FIG. 1

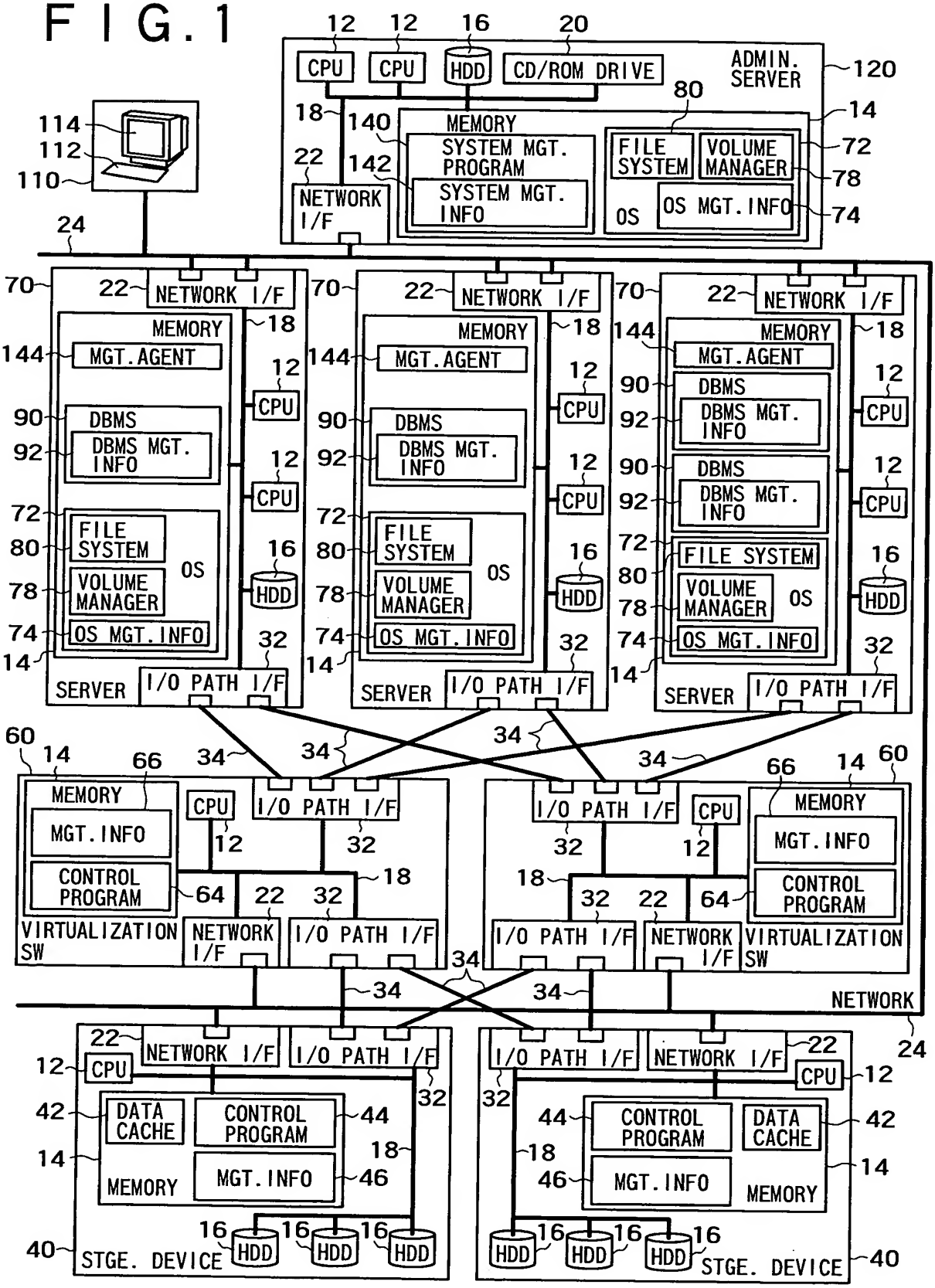

ADMIN. SERVER
CPU
CPU
HDD
CD/ROM DRIVE
MEMORY
SYSTEM MGT. PROGRAM
SYSTEM MGT. INFO
FILE SYSTEM
VOLUME MANAGER
OS
OS MGT. INFO
NETWORK I/F
SERVER
I/O PATH I/F
MGT. AGENT
DBMS
DBMS MGT. INFO
MGT. INFO
CONTROL PROGRAM
VIRTUALIZATION SW
NETWORK
DATA CACHE
STGE. DEVICE

FIG.2

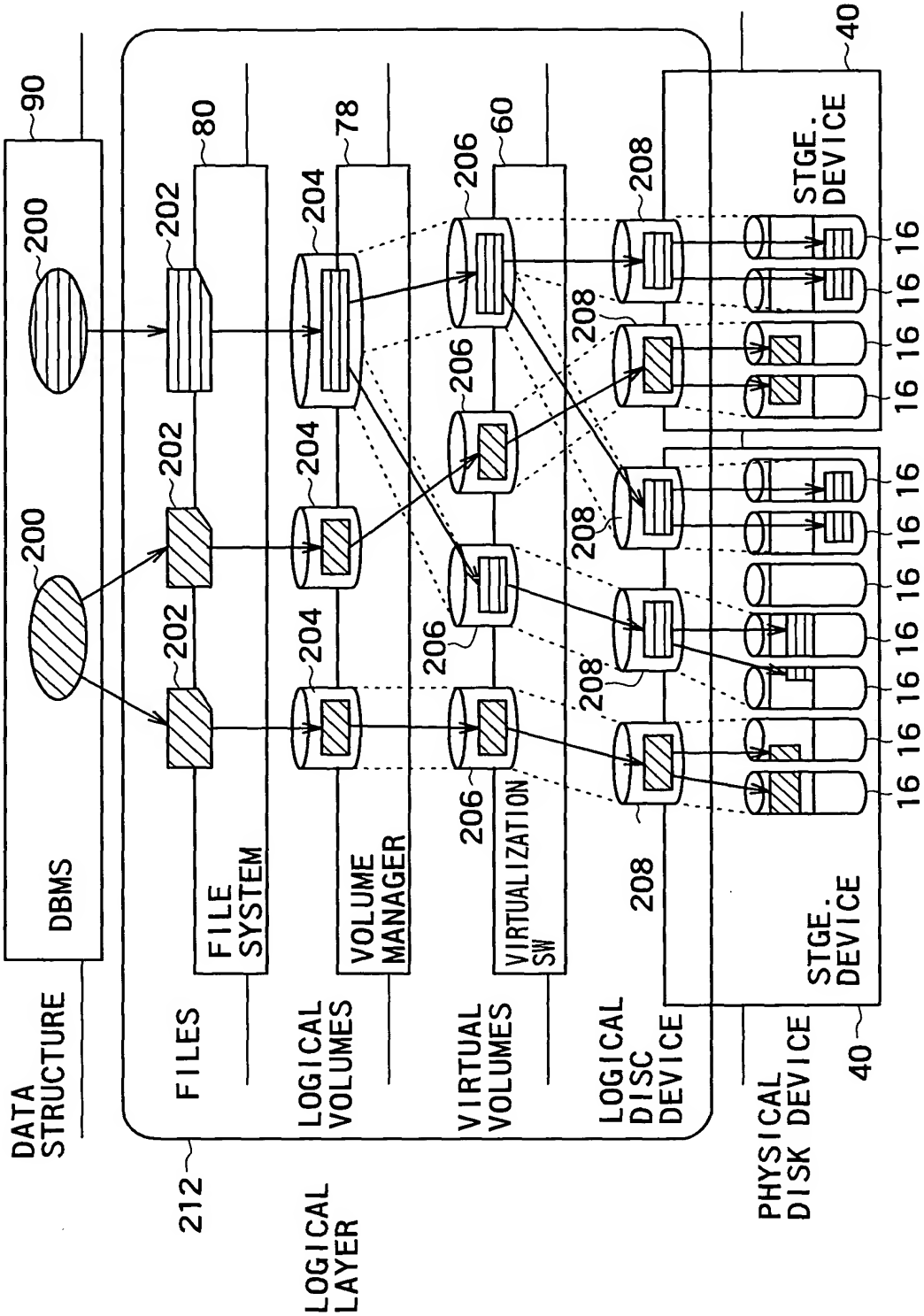

DATA STRUCTURE
DBMS
90
200
200
212
LOGICAL LAYER
FILES
FILE SYSTEM
80
202
202
202
LOGICAL VOLUMES
VOLUME MANAGER
78
204
204
204
VIRTUAL VOLUMES
VIRTUALIZATION SW
60
206
206
206
206
LOGICAL DISC DEVICE
208
208
208
208
208
PHYSICAL DISK DEVICE
STGE. DEVICE
STGE. DEVICE
40
40
16

FIG.3

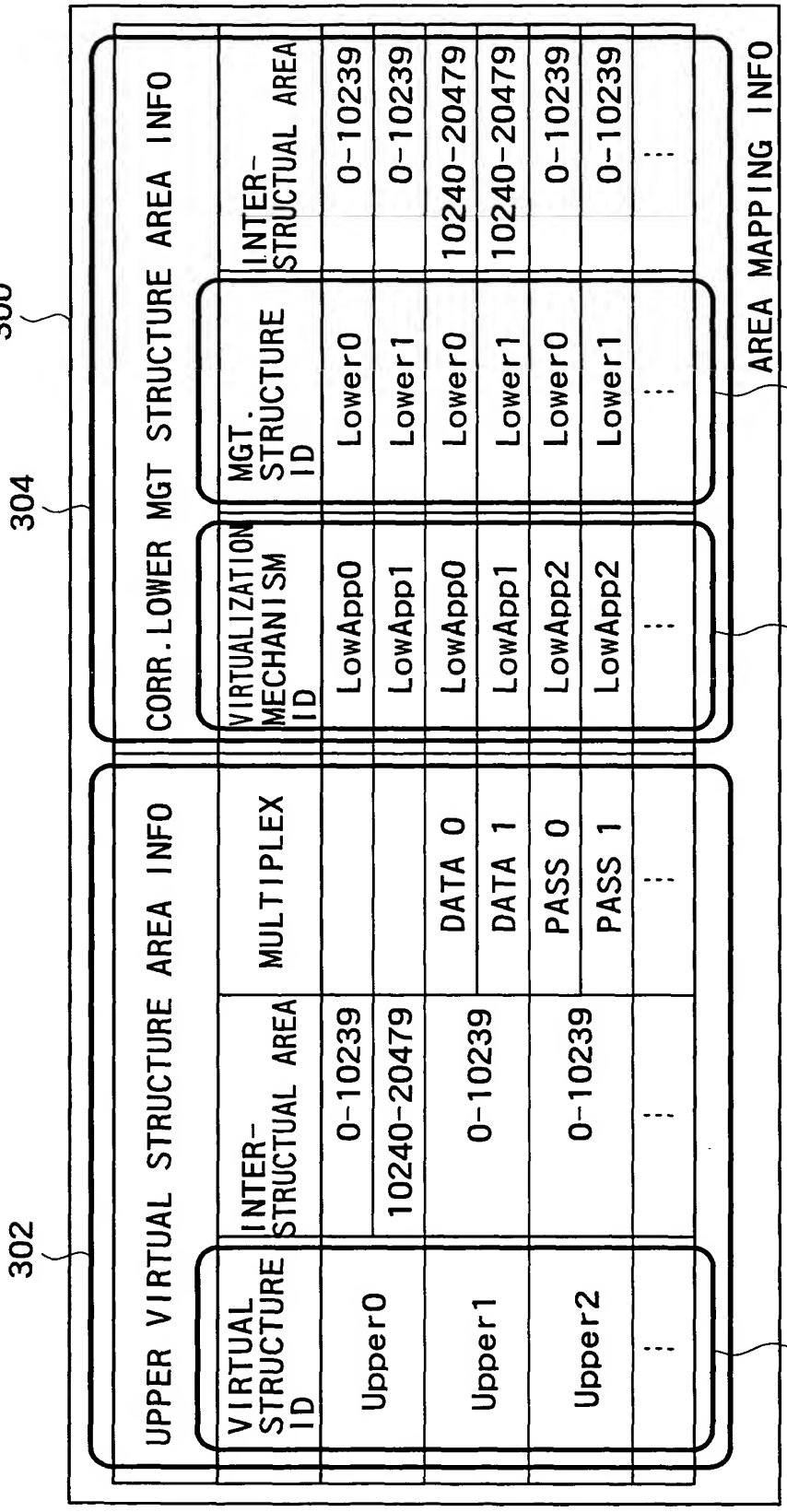

300
302
304
306
308
310
AREA MAPPING INFO
UPPER VIRTUAL STRUCTURE AREA INFO
VIRTUAL STRUCTURE ID
INTER-STRUCTUAL AREA
MULTIPLEX
Upper0
0-10239
10240-20479
Upper1
0-10239
DATA 0
DATA 1
Upper2
0-10239
PASS 0
PASS 1
CORR.LOWER MGT STRUCTURE AREA INFO
VIRTUALIZATION MECHANISM ID
LowApp0
LowApp1
LowApp0
LowApp1
LowApp2
LowApp2
MGT. STRUCTURE ID
Lower0
Lower1
Lower0
Lower1
Lower0
Lower1
INTER-STRUCTUAL AREA
0-10239
0-10239
10240-20479
10240-20479
0-10239
0-10239

FIG. 4

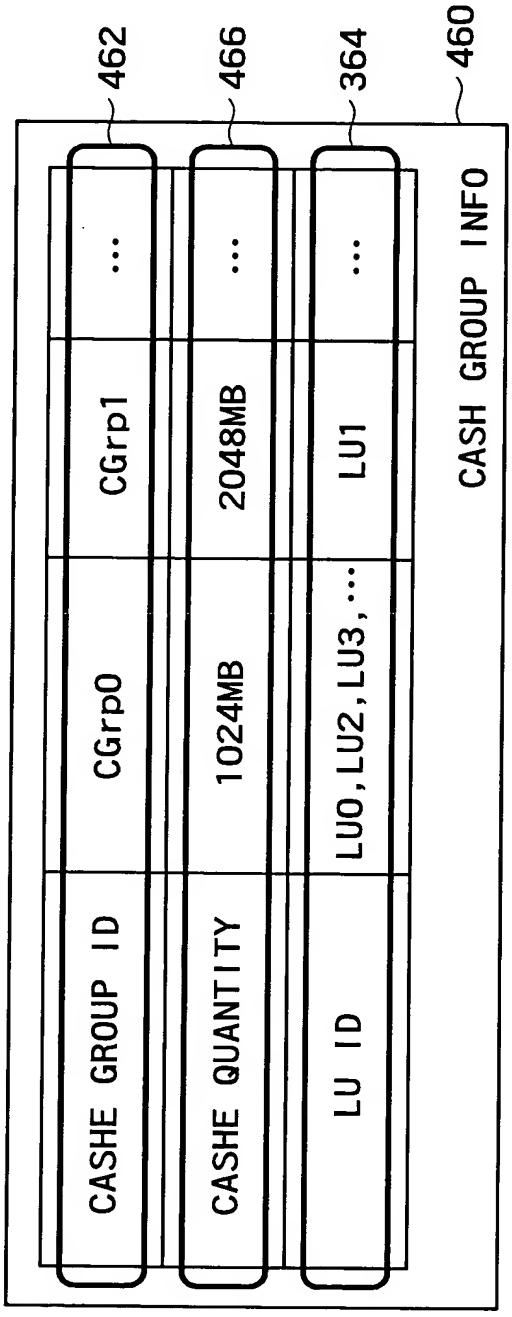

462
466
364
460
CASH GROUP ID
CASHE QUANTITY
LU ID
CGrp0
1024MB
LU0, LU2, LU3, ...
CGrp1
2048MB
LU1
...
...
...
CASH GROUP INFO

FIG.5

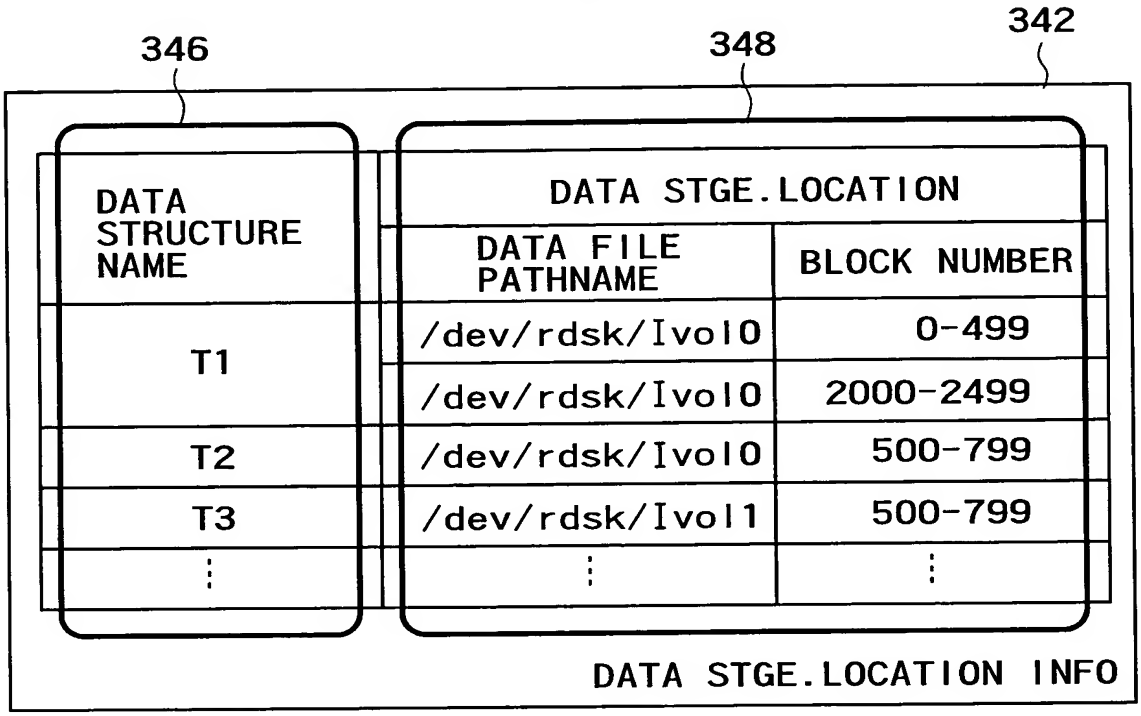

346
348
342
DATA STRUCTURE NAME
DATA STGE.LOCATION
DATA FILE PATHNAME
BLOCK NUMBER
T1
/dev/rdsk/Ivol0
0-499
/dev/rdsk/Ivol0
2000-2499
T2
/dev/rdsk/Ivol0
500-799
T3
/dev/rdsk/Ivol1
500-799
DATA STGE.LOCATION INFO

FIG.6

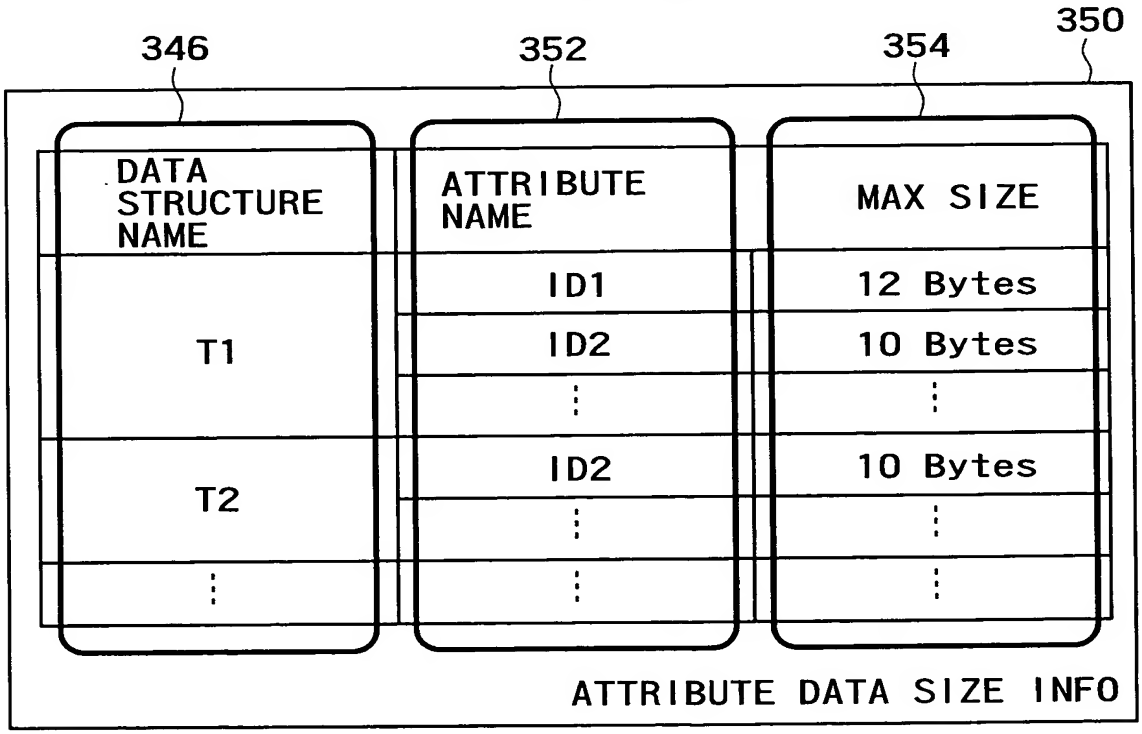

346
352
354
350
DATA STRUCTURE NAME
ATTRIBUTE NAME
MAX SIZE
T1
ID1
12 Bytes
ID2
10 Bytes
T2
ID2
10 Bytes
ATTRIBUTE DATA SIZE INFO

FIG.7

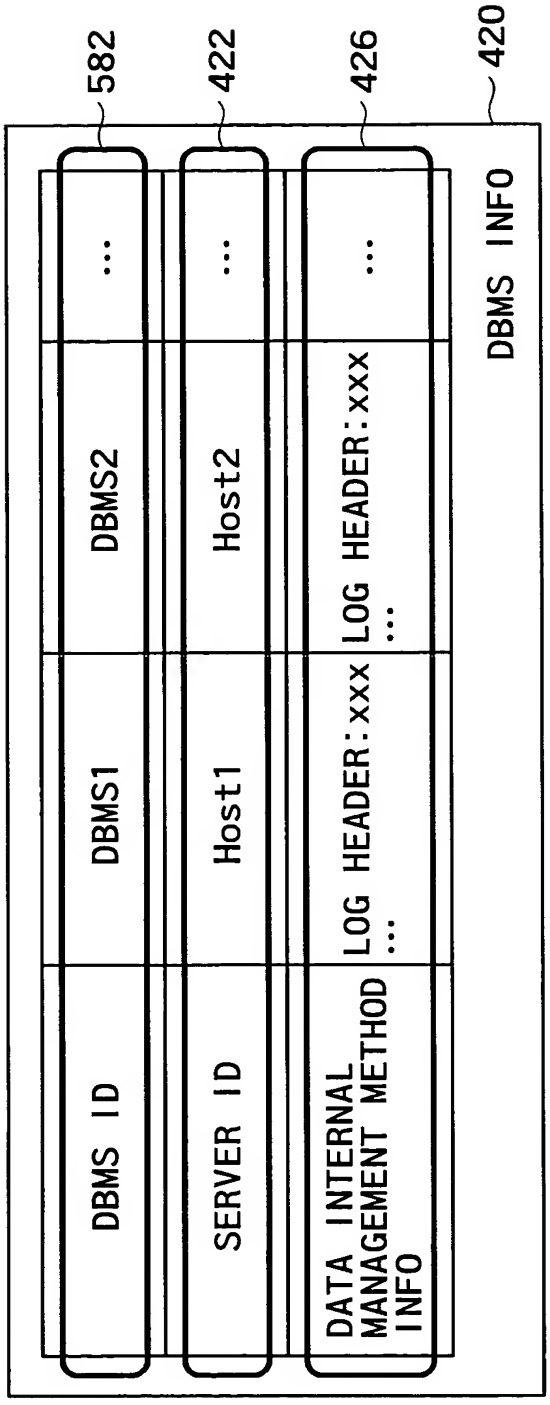

582
422
426
420
DBMS INFO
DBMS ID
DBMS1
DBMS2
...
SERVER ID
Host1
Host2
...
DATA INTERNAL MANAGEMENT METHOD INFO
LOG HEADER:xxx
...
LOG HEADER:xxx
...
...

FIG.8

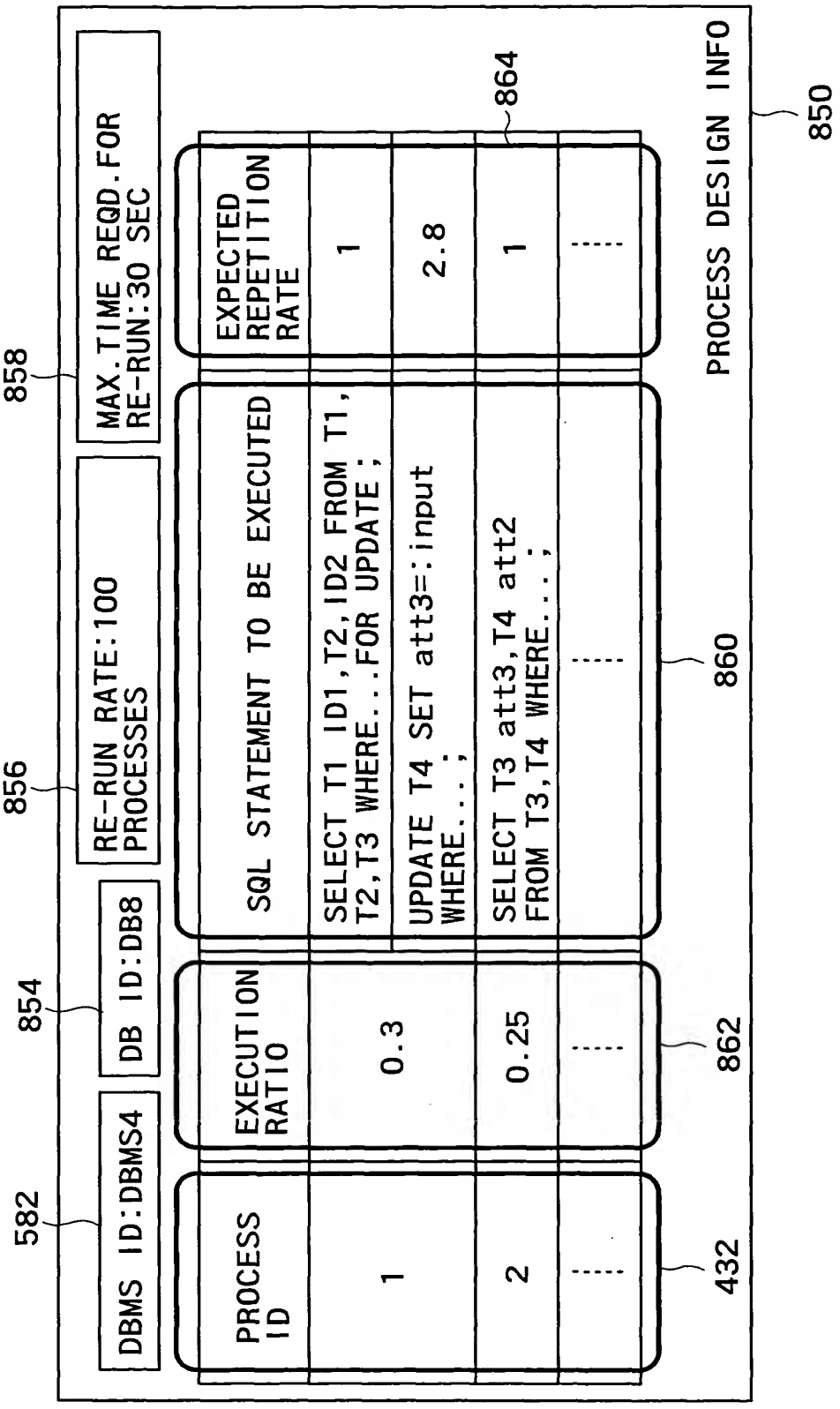

582
DBMS ID:DBMS4
854
DB ID:DB8
856
RE-RUN RATE:100 PROCESSES
858
MAX.TIME REQD.FOR RE-RUN:30 SEC
PROCESS ID
EXECUTION RATIO
SQL STATEMENT TO BE EXECUTED
EXPECTED REPETITION RATE
1
0.3
SELECT T1 ID1,T2,ID2 FROM T1, T2,T3 WHERE...FOR UPDATE;
1
2
0.25
UPDATE T4 SET att3=:input WHERE...;
2.8
SELECT T3 att3,T4 att2 FROM T3,T4 WHERE...;
1
.....
.....
.....
.....
432
862
860
864
PROCESS DESIGN INFO
850

FIG.9

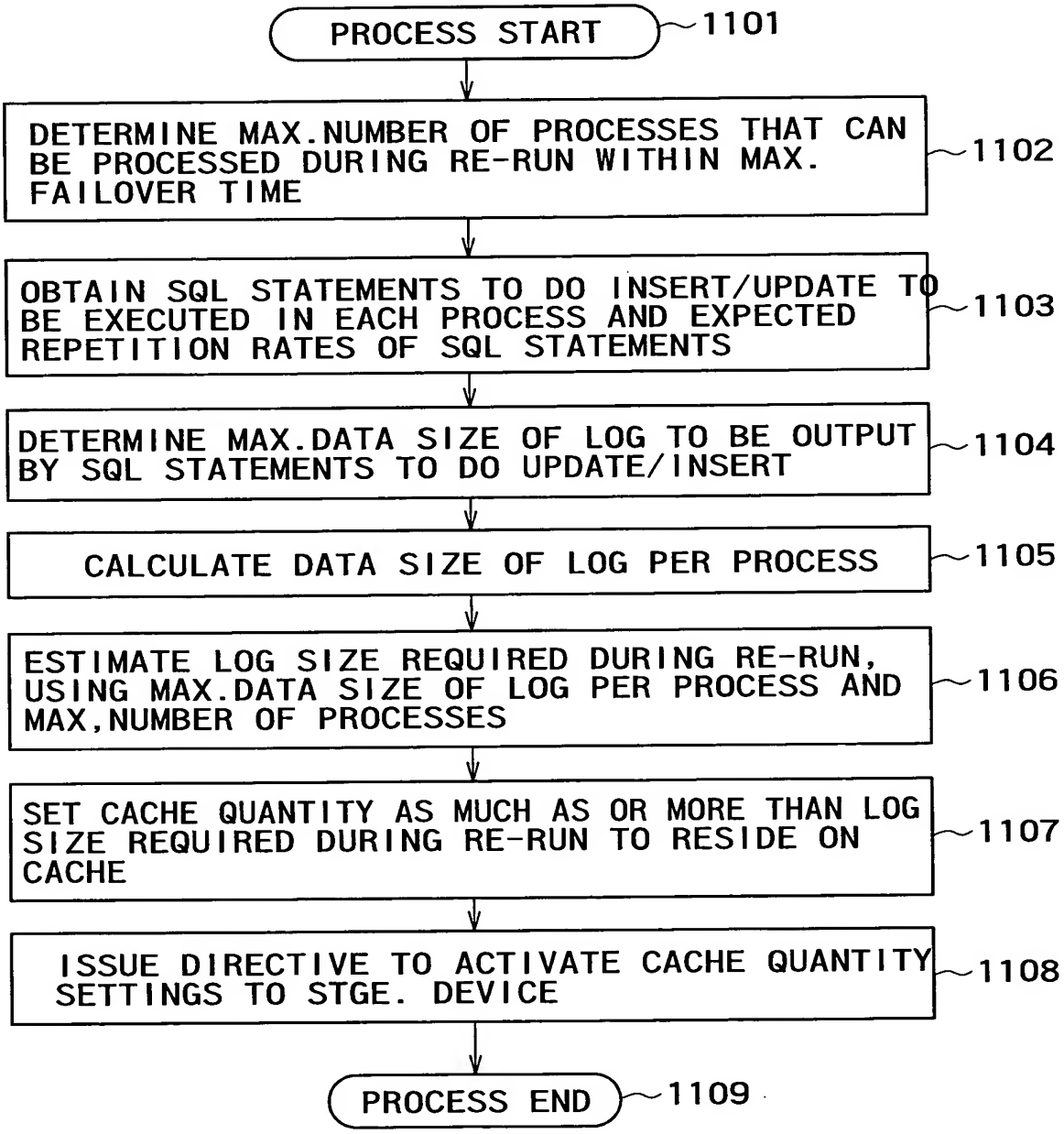

PROCESS START
1101
DETERMINE MAX.NUMBER OF PROCESSES THAT CAN BE PROCESSED DURING RE-RUN WITHIN MAX. FAILOVER TIME
1102
OBTAIN SQL STATEMENTS TO DO INSERT/UPDATE TO BE EXECUTED IN EACH PROCESS AND EXPECTED REPETITION RATES OF SQL STATEMENTS
1103
DETERMINE MAX.DATA SIZE OF LOG TO BE OUTPUT BY SQL STATEMENTS TO DO UPDATE/INSERT
1104
CALCULATE DATA SIZE OF LOG PER PROCESS
1105
ESTIMATE LOG SIZE REQUIRED DURING RE-RUN, USING MAX.DATA SIZE OF LOG PER PROCESS AND MAX,NUMBER OF PROCESSES
1106
SET CACHE QUANTITY AS MUCH AS OR MORE THAN LOG SIZE REQUIRED DURING RE-RUN TO RESIDE ON CACHE
1107
ISSUE DIRECTIVE TO ACTIVATE CACHE QUANTITY SETTINGS TO STGE. DEVICE
1108
PROCESS END
1109

FIG. 10

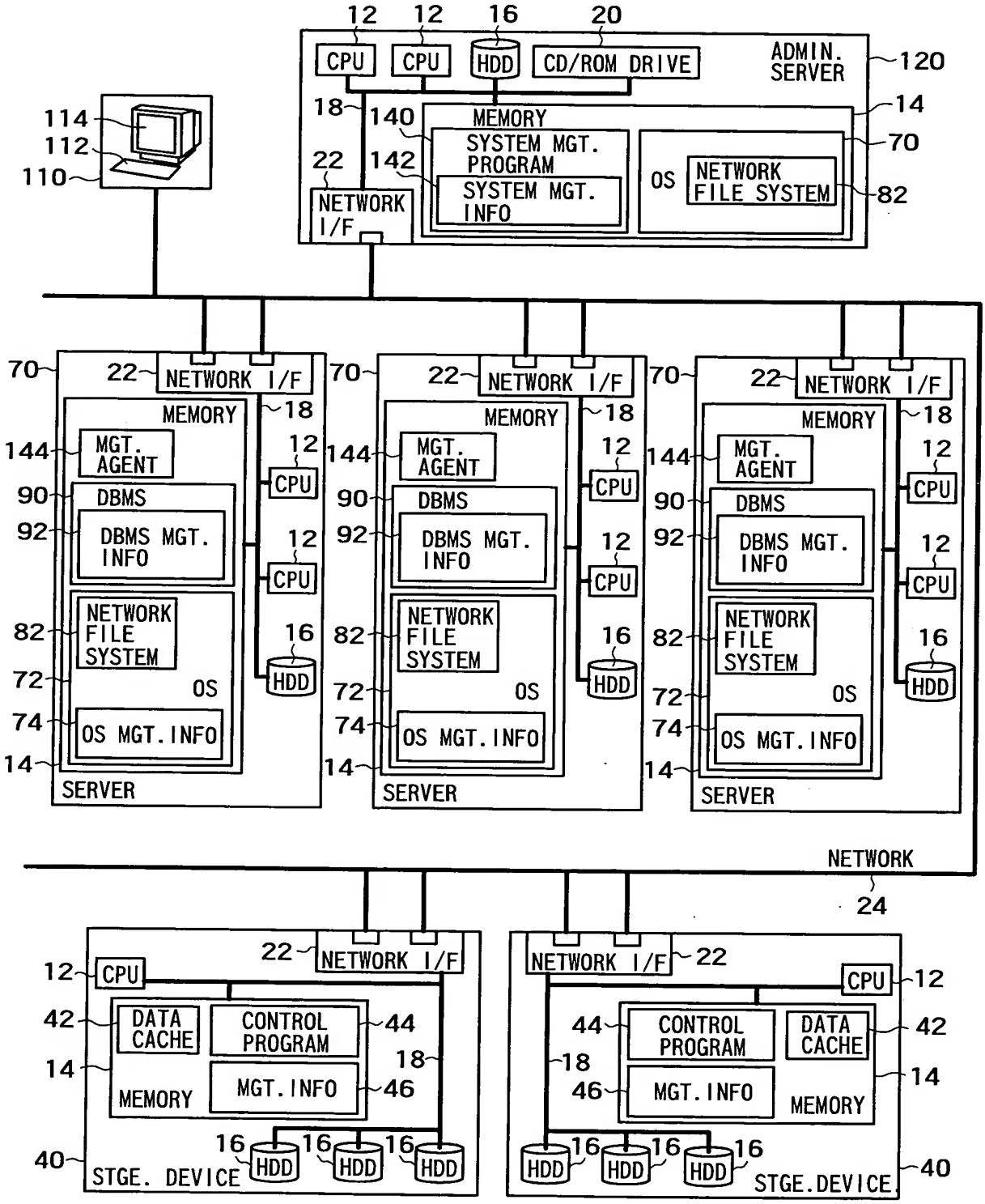

12
12
16
20
CPU
CPU
HDD
CD/ROM DRIVE
ADMIN. SERVER
120
114
112
110
18
140
MEMORY
14
SYSTEM MGT. PROGRAM
70
22
142
SYSTEM MGT. INFO
OS
NETWORK FILE SYSTEM
82
NETWORK I/F
70
22
NETWORK I/F
MEMORY
18
144
MGT. AGENT
12
CPU
90
DBMS
92
DBMS MGT. INFO
12
CPU
NETWORK FILE SYSTEM
82
16
HDD
72
OS
74
OS MGT. INFO
14
SERVER
NETWORK
24
22
NETWORK I/F
12
CPU
42
DATA CACHE
CONTROL PROGRAM
44
14
18
MEMORY
MGT. INFO
46
16
HDD
40
STGE. DEVICE

FIG. 11

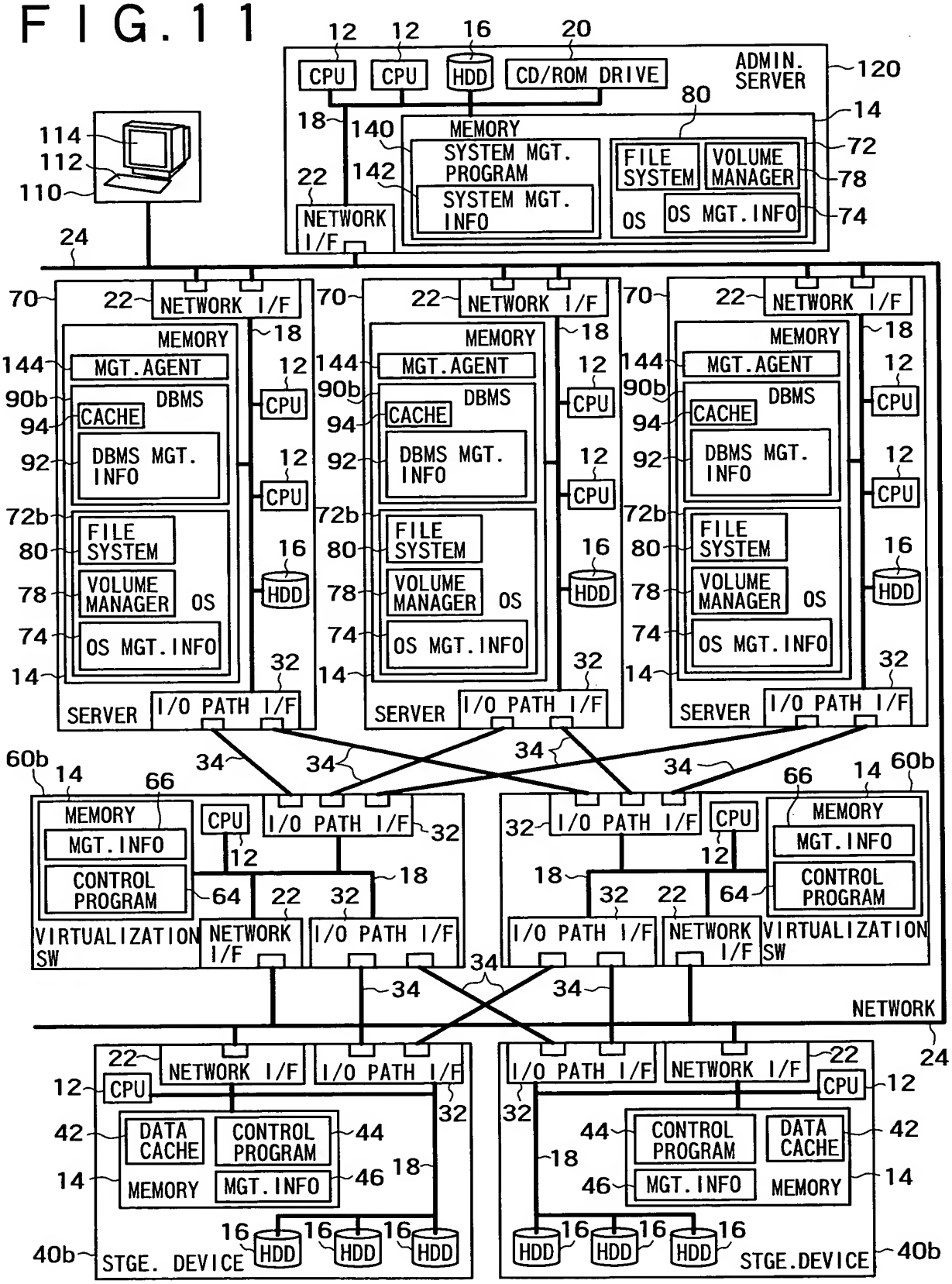

ADMIN. SERVER
CPU
CD/ROM DRIVE
HDD
MEMORY
SYSTEM MGT. PROGRAM
SYSTEM MGT. INFO
FILE SYSTEM
VOLUME MANAGER
OS
OS MGT. INFO
NETWORK I/F
SERVER
MGT. AGENT
DBMS
CACHE
DBMS MGT. INFO
I/O PATH I/F
VIRTUALIZATION SW
MGT. INFO
CONTROL PROGRAM
NETWORK
STGE. DEVICE
DATA CACHE

FIG. 12

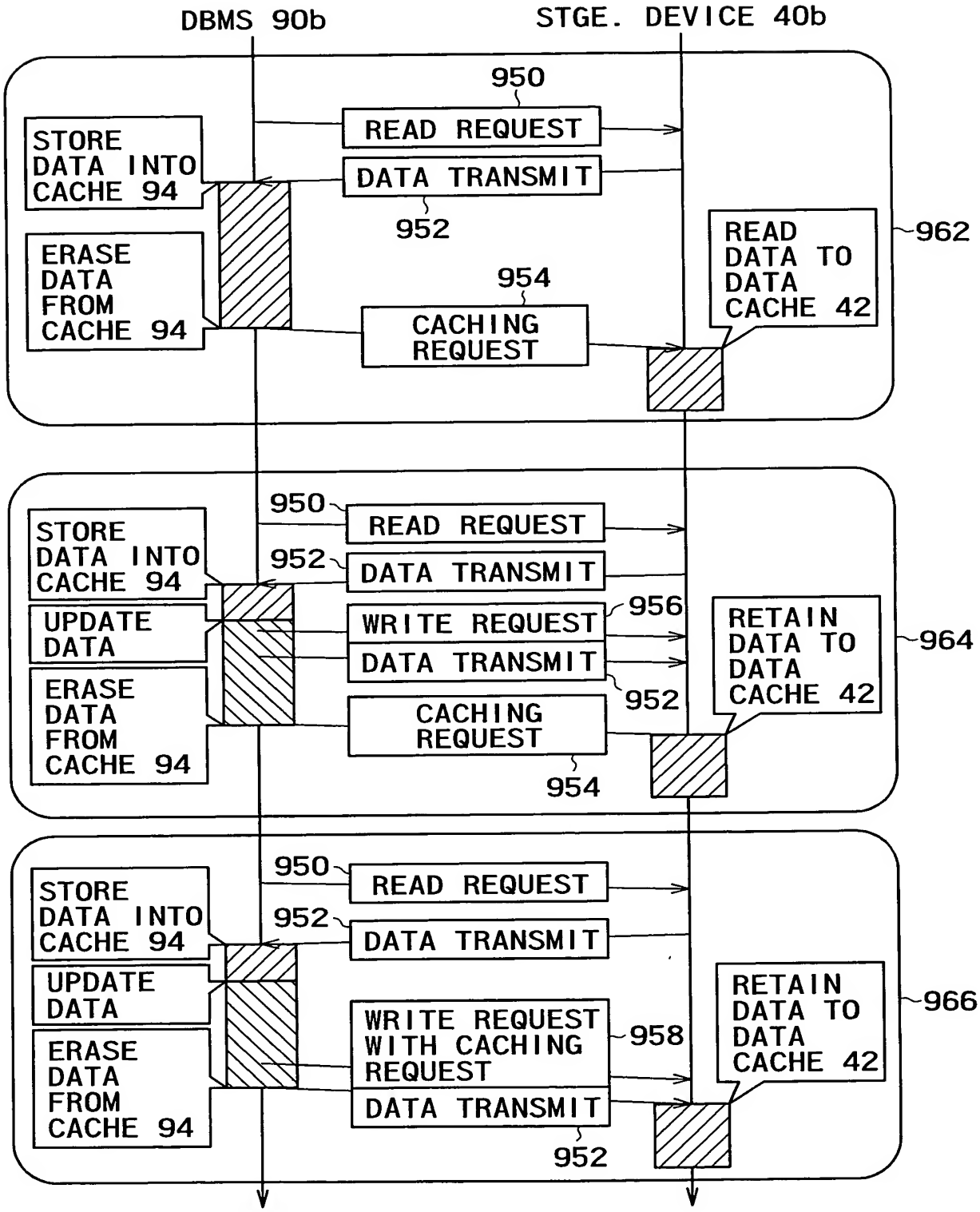

DBMS 90b
STGE. DEVICE 40b
950
READ REQUEST
STORE DATA INTO CACHE 94
DATA TRANSMIT
952
ERASE DATA FROM CACHE 94
954
CACHING REQUEST
READ DATA TO DATA CACHE 42
962
950
READ REQUEST
STORE DATA INTO CACHE 94
952
DATA TRANSMIT
UPDATE DATA
WRITE REQUEST
956
DATA TRANSMIT
952
ERASE DATA FROM CACHE 94
CACHING REQUEST
954
RETAIN DATA TO DATA CACHE 42
964
950
READ REQUEST
STORE DATA INTO CACHE 94
952
DATA TRANSMIT
UPDATE DATA
WRITE REQUEST WITH CACHING REQUEST
958
ERASE DATA FROM CACHE 94
DATA TRANSMIT
952
RETAIN DATA TO DATA CACHE 42
966

FIG.13

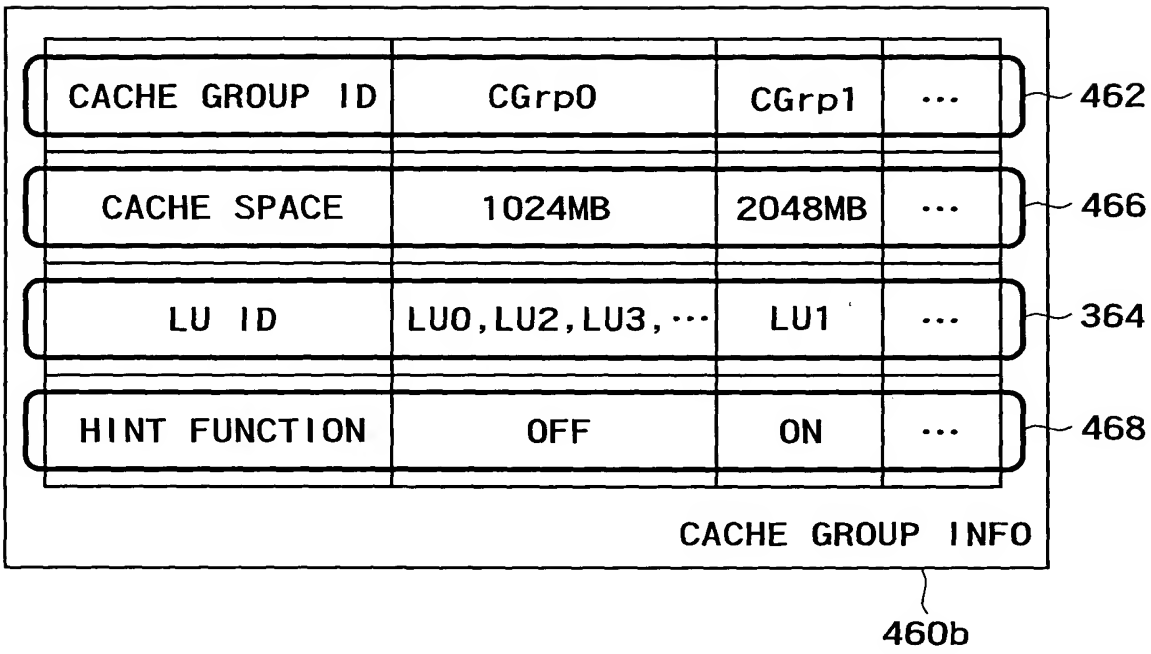

CACHE GROUP ID
CGrp0
CGrp1
...
462
CACHE SPACE
1024MB
2048MB
...
466
LU ID
LU0,LU2,LU3,...
LU1
...
364
HINT FUNCTION
OFF
ON
...
468
CACHE GROUP INFO
460b

FIG.14

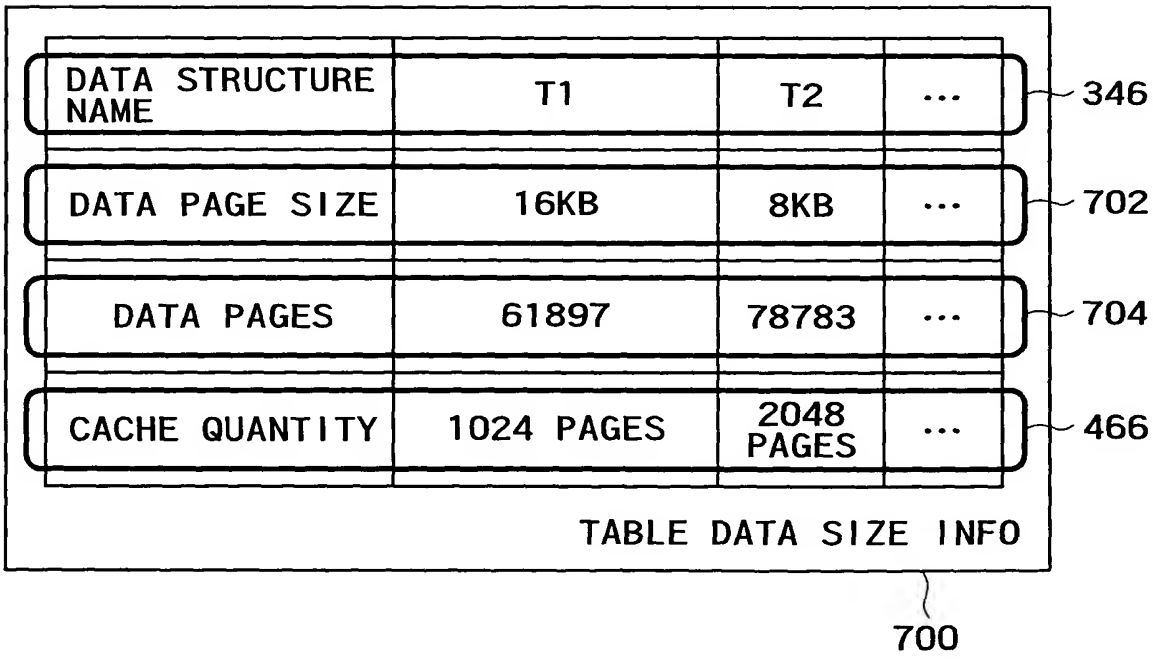

DATA STRUCTURE NAME
T1
T2
...
346
DATA PAGE SIZE
16KB
8KB
...
702
DATA PAGES
61897
78783
...
704
CACHE QUANTITY
1024 PAGES
2048 PAGES
...
466
TABLE DATA SIZE INFO
700

FIG.15

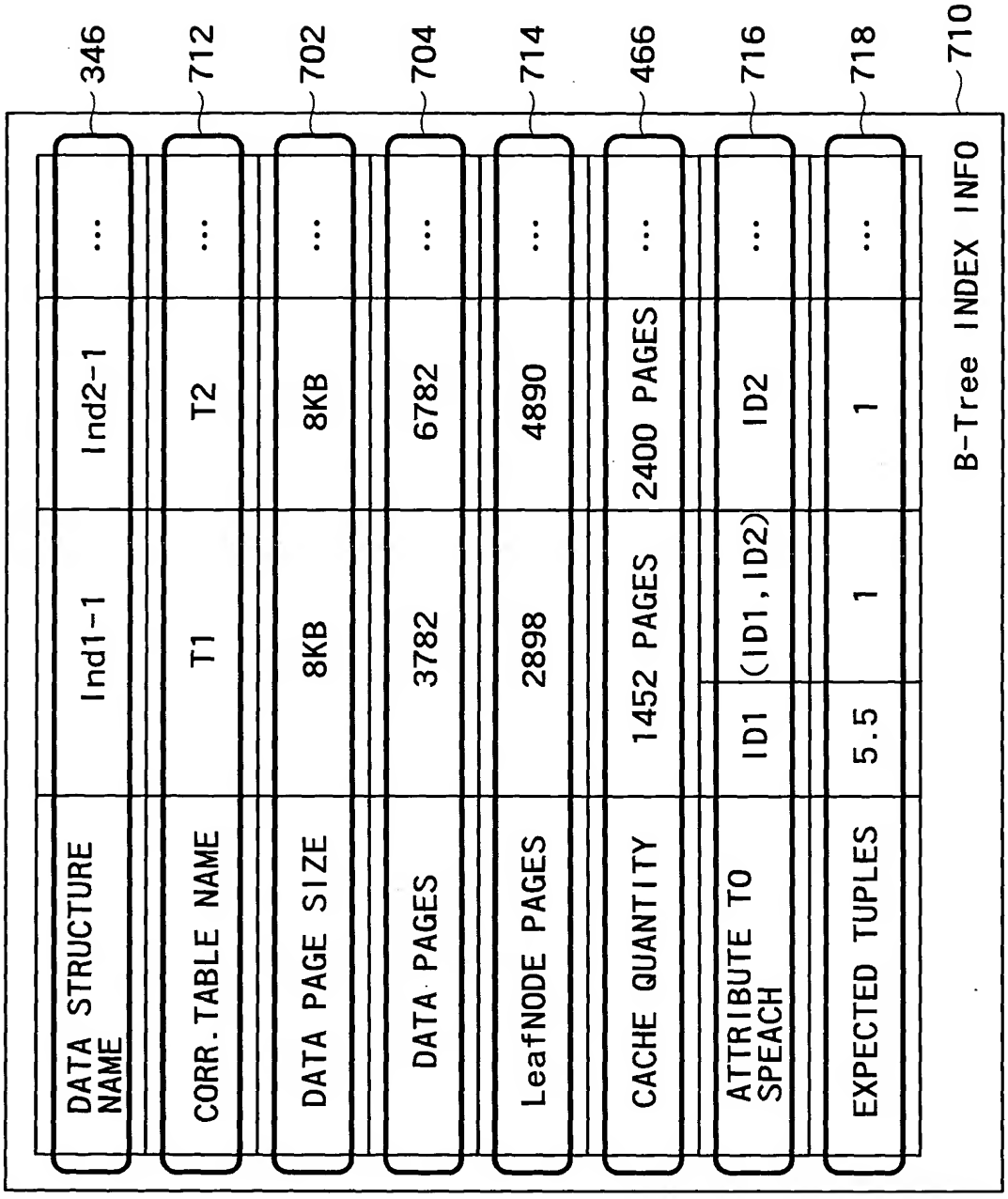

346
712
702
704
714
466
716
718
710
DATA STRUCTURE NAME
CORR. TABLE NAME
DATA PAGE SIZE
DATA PAGES
LeafNODE PAGES
CACHE QUANTITY
ATTRIBUTE TO SPEACH
EXPECTED TUPLES
Ind1-1
T1
8KB
3782
2898
1452 PAGES
ID1
5.5
Ind2-1
T2
8KB
6782
4890
2400 PAGES
(ID1, ID2)
ID2
1
1
...
B-Tree INDEX INFO

FIG.16

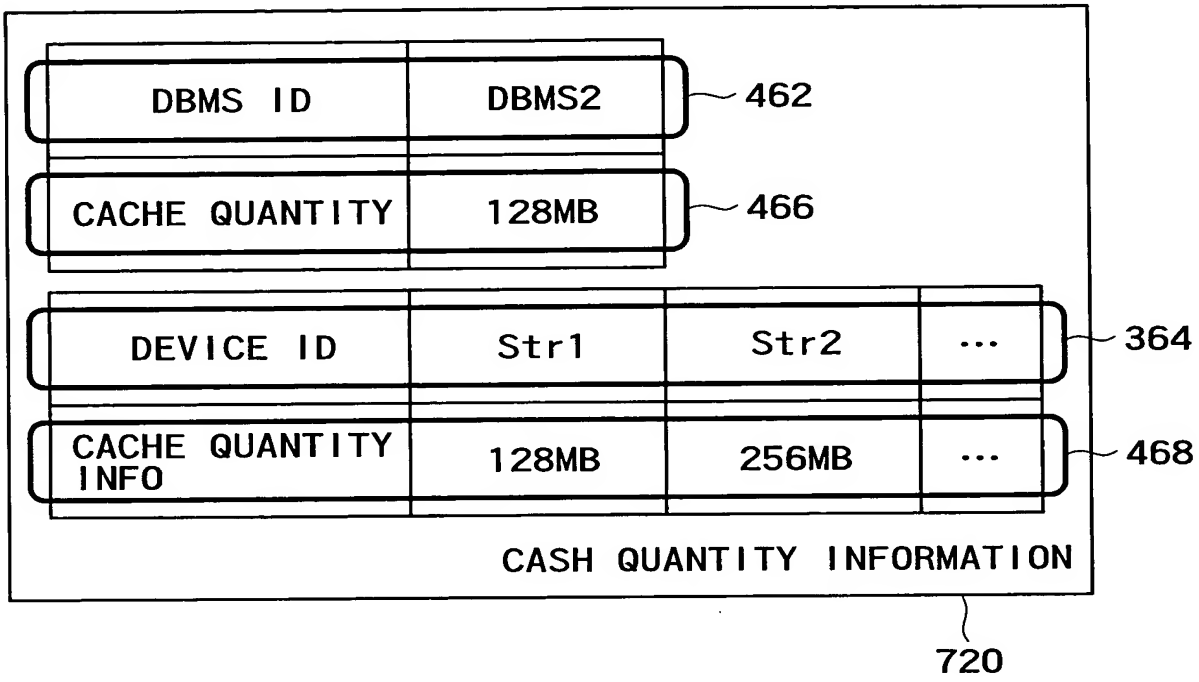

DBMS ID
DBMS2
462
CACHE QUANTITY
128MB
466
DEVICE ID
Str1
Str2
...
364
CACHE QUANTITY INFO
128MB
256MB
...
468
CASH QUANTITY INFORMATION
720

FIG.17

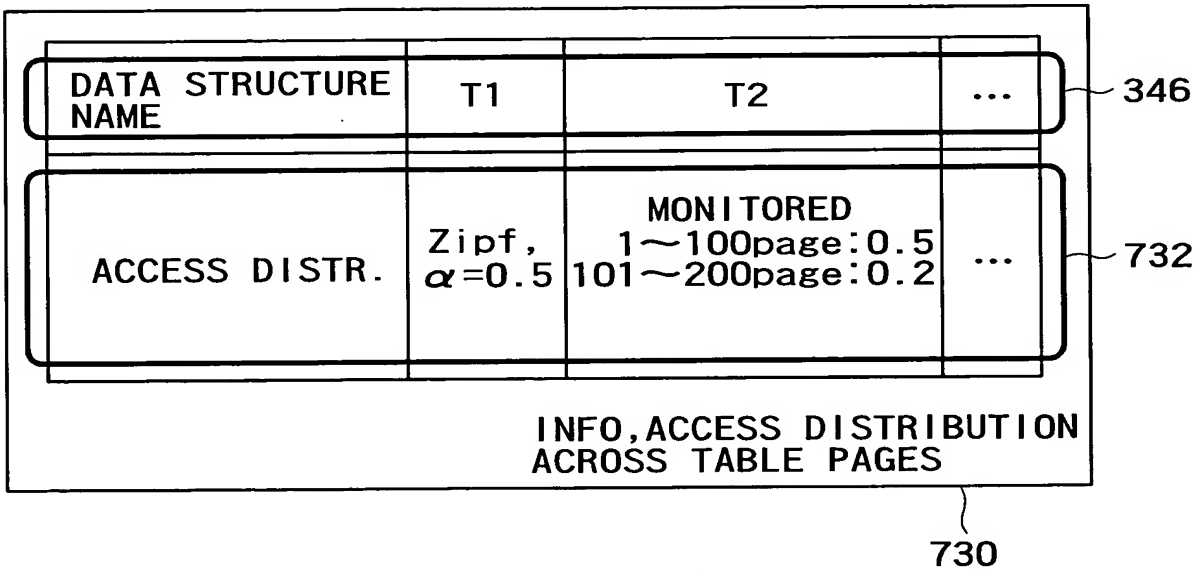

DATA STRUCTURE NAME
T1
T2
...
346
ACCESS DISTR.
Zipf, α=0.5
MONITORED
1～100page:0.5
101～200page:0.2
...
732
INFO,ACCESS DISTRIBUTION ACROSS TABLE PAGES
730

FIG.18

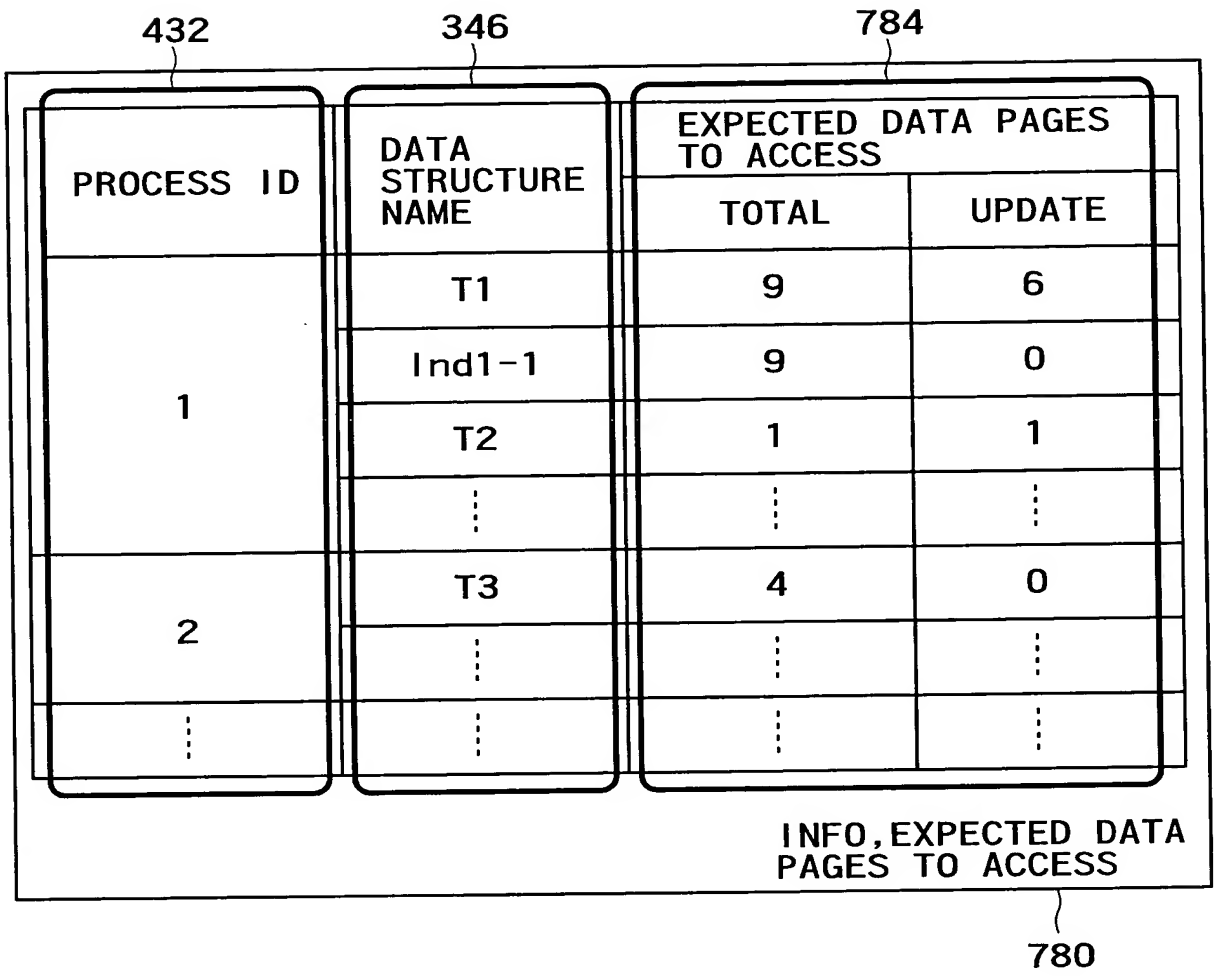

432
346
784
PROCESS ID
DATA STRUCTURE NAME
EXPECTED DATA PAGES TO ACCESS
TOTAL
UPDATE
1
T1
9
6
Ind1-1
9
0
T2
1
1
2
T3
4
0
INFO, EXPECTED DATA PAGES TO ACCESS
780

FIG. 19

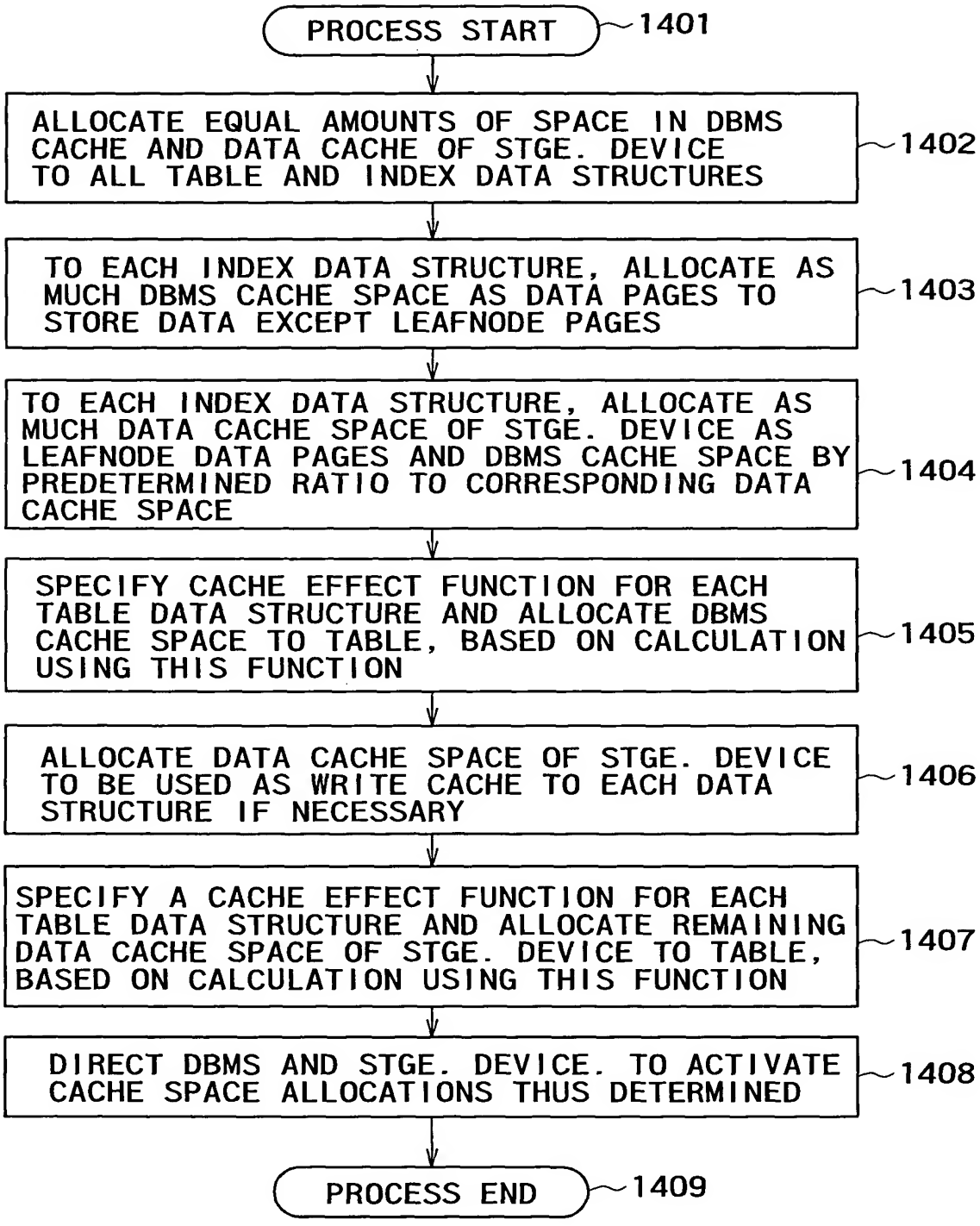

PROCESS START
1401
ALLOCATE EQUAL AMOUNTS OF SPACE IN DBMS CACHE AND DATA CACHE OF STGE. DEVICE TO ALL TABLE AND INDEX DATA STRUCTURES
1402
TO EACH INDEX DATA STRUCTURE, ALLOCATE AS MUCH DBMS CACHE SPACE AS DATA PAGES TO STORE DATA EXCEPT LEAFNODE PAGES
1403
TO EACH INDEX DATA STRUCTURE, ALLOCATE AS MUCH DATA CACHE SPACE OF STGE. DEVICE AS LEAFNODE DATA PAGES AND DBMS CACHE SPACE BY PREDETERMINED RATIO TO CORRESPONDING DATA CACHE SPACE
1404
SPECIFY CACHE EFFECT FUNCTION FOR EACH TABLE DATA STRUCTURE AND ALLOCATE DBMS CACHE SPACE TO TABLE, BASED ON CALCULATION USING THIS FUNCTION
1405
ALLOCATE DATA CACHE SPACE OF STGE. DEVICE TO BE USED AS WRITE CACHE TO EACH DATA STRUCTURE IF NECESSARY
1406
SPECIFY A CACHE EFFECT FUNCTION FOR EACH TABLE DATA STRUCTURE AND ALLOCATE REMAINING DATA CACHE SPACE OF STGE. DEVICE TO TABLE, BASED ON CALCULATION USING THIS FUNCTION
1407
DIRECT DBMS AND STGE. DEVICE. TO ACTIVATE CACHE SPACE ALLOCATIONS THUS DETERMINED
1408
PROCESS END
1409

FIG.20

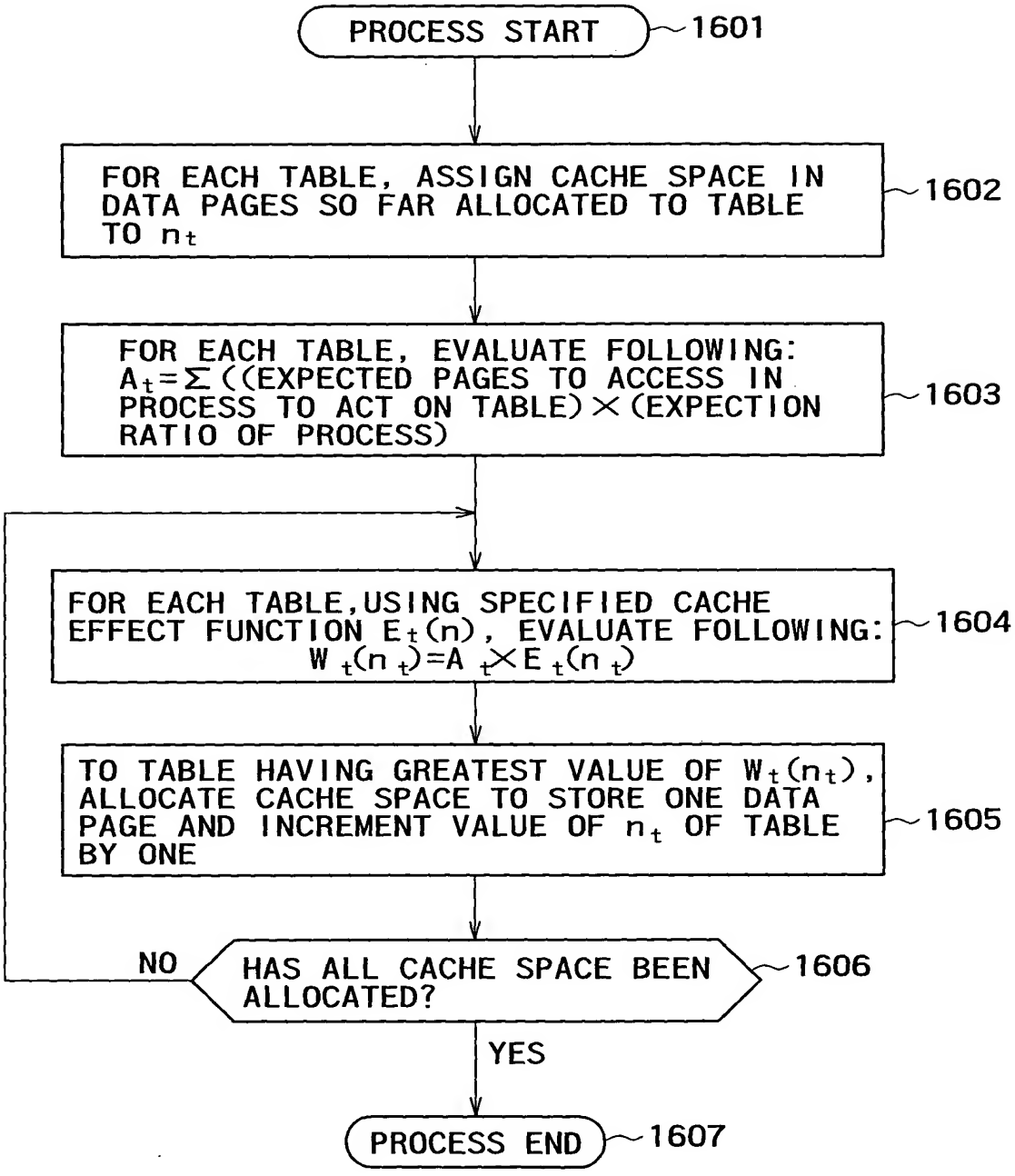

PROCESS START
1601
FOR EACH TABLE, ASSIGN CACHE SPACE IN DATA PAGES SO FAR ALLOCATED TO TABLE TO n_t
1602
FOR EACH TABLE, EVALUATE FOLLOWING: $A_t=\Sigma$((EXPECTED PAGES TO ACCESS IN PROCESS TO ACT ON TABLE)×(EXPECTION RATIO OF PROCESS)
1603
FOR EACH TABLE,USING SPECIFIED CACHE EFFECT FUNCTION $E_t(n)$, EVALUATE FOLLOWING: $W_t(n_t)=A_t \times E_t(n_t)$
1604
TO TABLE HAVING GREATEST VALUE OF $W_t(n_t)$, ALLOCATE CACHE SPACE TO STORE ONE DATA PAGE AND INCREMENT VALUE OF n_t OF TABLE BY ONE
1605
NO
HAS ALL CACHE SPACE BEEN ALLOCATED?
1606
YES
PROCESS END
1607

FIG.21

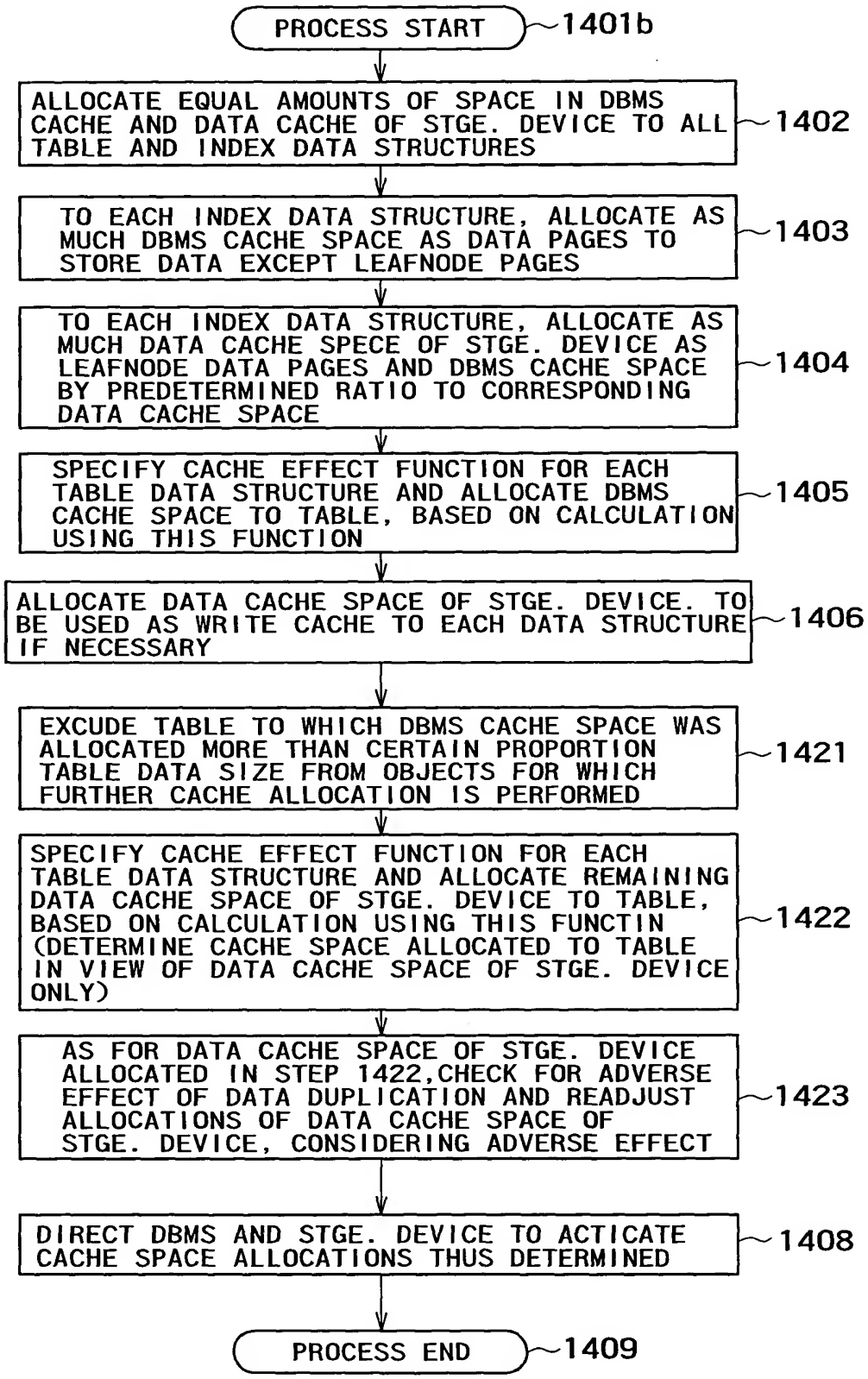

PROCESS START
1401b
ALLOCATE EQUAL AMOUNTS OF SPACE IN DBMS CACHE AND DATA CACHE OF STGE. DEVICE TO ALL TABLE AND INDEX DATA STRUCTURES
1402
TO EACH INDEX DATA STRUCTURE, ALLOCATE AS MUCH DBMS CACHE SPACE AS DATA PAGES TO STORE DATA EXCEPT LEAFNODE PAGES
1403
TO EACH INDEX DATA STRUCTURE, ALLOCATE AS MUCH DATA CACHE SPECE OF STGE. DEVICE AS LEAFNODE DATA PAGES AND DBMS CACHE SPACE BY PREDETERMINED RATIO TO CORRESPONDING DATA CACHE SPACE
1404
SPECIFY CACHE EFFECT FUNCTION FOR EACH TABLE DATA STRUCTURE AND ALLOCATE DBMS CACHE SPACE TO TABLE, BASED ON CALCULATION USING THIS FUNCTION
1405
ALLOCATE DATA CACHE SPACE OF STGE. DEVICE. TO BE USED AS WRITE CACHE TO EACH DATA STRUCTURE IF NECESSARY
1406
EXCUDE TABLE TO WHICH DBMS CACHE SPACE WAS ALLOCATED MORE THAN CERTAIN PROPORTION TABLE DATA SIZE FROM OBJECTS FOR WHICH FURTHER CACHE ALLOCATION IS PERFORMED
1421
SPECIFY CACHE EFFECT FUNCTION FOR EACH TABLE DATA STRUCTURE AND ALLOCATE REMAINING DATA CACHE SPACE OF STGE. DEVICE TO TABLE, BASED ON CALCULATION USING THIS FUNCTIN (DETERMINE CACHE SPACE ALLOCATED TO TABLE IN VIEW OF DATA CACHE SPACE OF STGE. DEVICE ONLY)
1422
AS FOR DATA CACHE SPACE OF STGE. DEVICE ALLOCATED IN STEP 1422,CHECK FOR ADVERSE EFFECT OF DATA DUPLICATION AND READJUST ALLOCATIONS OF DATA CACHE SPACE OF STGE. DEVICE, CONSIDERING ADVERSE EFFECT
1423
DIRECT DBMS AND STGE. DEVICE TO ACTICATE CACHE SPACE ALLOCATIONS THUS DETERMINED
1408
PROCESS END
1409

FIG.22

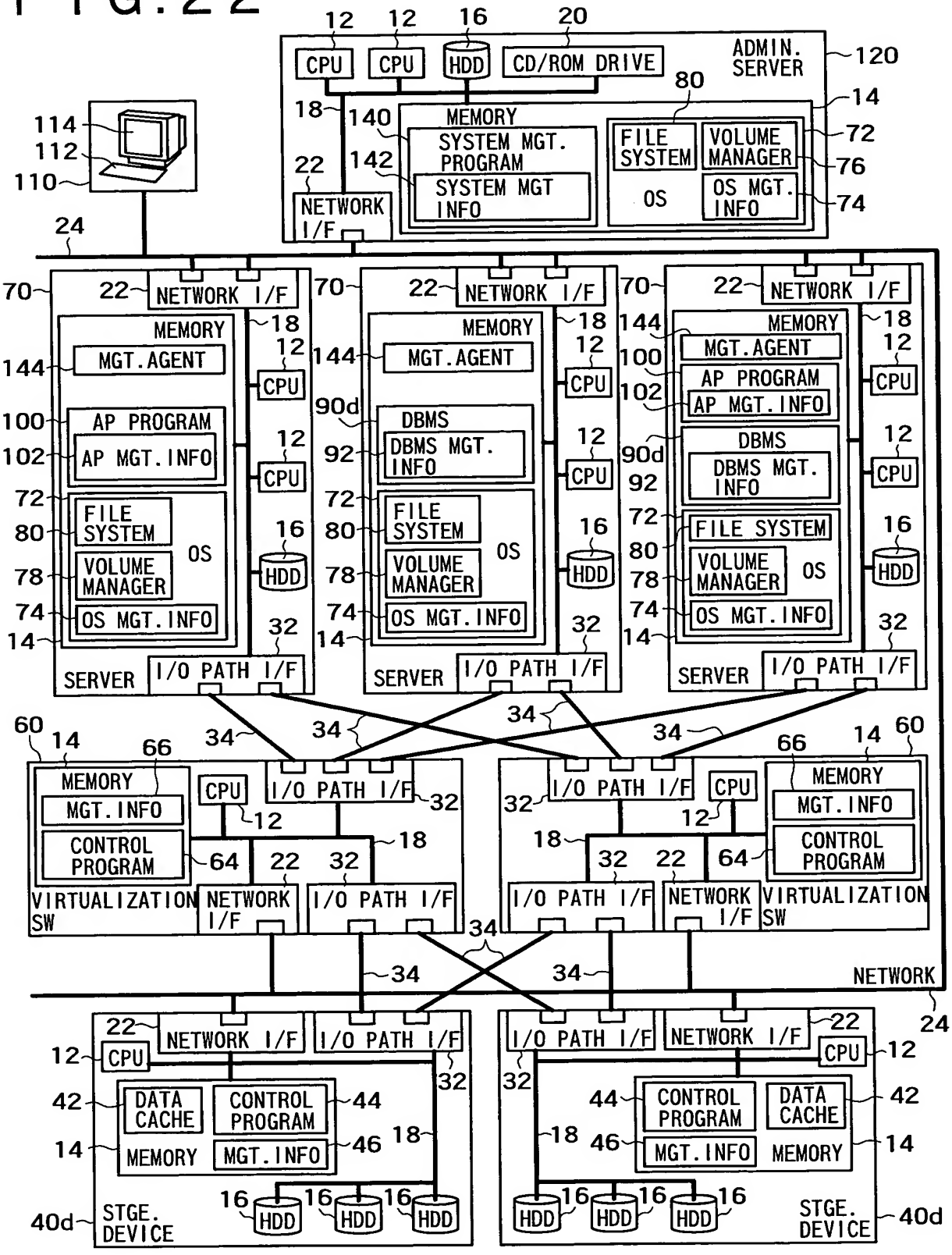

ADMIN. SERVER
CPU
HDD
CD/ROM DRIVE
MEMORY
SYSTEM MGT. PROGRAM
SYSTEM MGT INFO
FILE SYSTEM
VOLUME MANAGER
OS
OS MGT. INFO
NETWORK I/F
MGT.AGENT
AP PROGRAM
AP MGT.INFO
DBMS
DBMS MGT. INFO
SERVER
I/O PATH I/F
VIRTUALIZATION SW
MGT.INFO
CONTROL PROGRAM
NETWORK
DATA CACHE
STGE. DEVICE

FIG.23

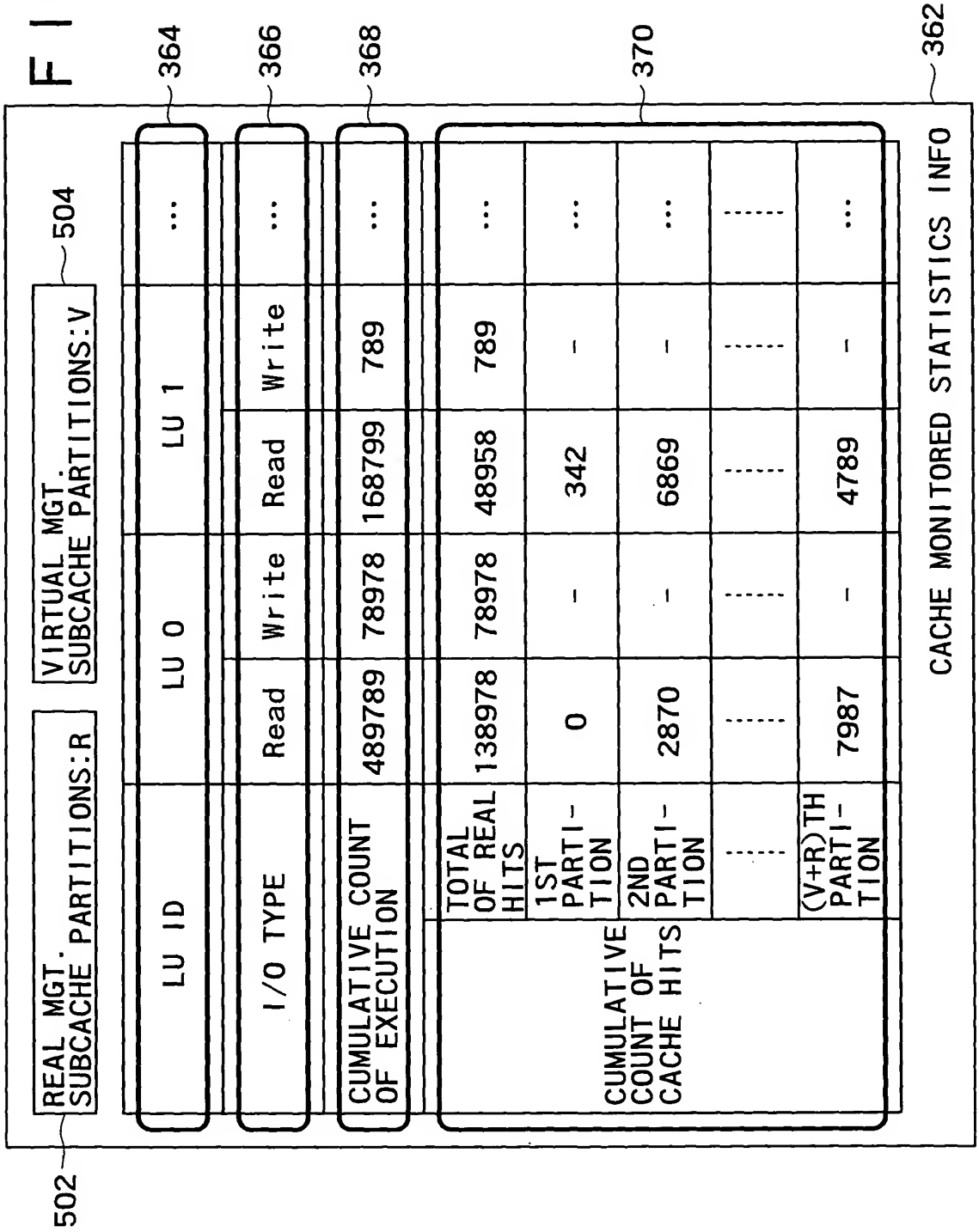

502
REAL MGT.
SUBCACHE PARTITIONS:R
VIRTUAL MGT.
SUBCACHE PARTITIONS:V
504
364
366
368
370
362
LU ID
LU 0
LU 1
...
I/O TYPE
Read
Write
Read
Write
CUMULATIVE COUNT OF EXECUTION
489789
78978
168799
789
CUMULATIVE COUNT OF CACHE HITS
TOTAL OF REAL HITS
138978
78978
48958
789
1ST PARTI-TION
0
-
342
-
2ND PARTI-TION
2870
-
6869
-
(V+R)TH PARTI-TION
7987
-
4789
-
CACHE MONITORED STATISTICS INFO

FIG.24

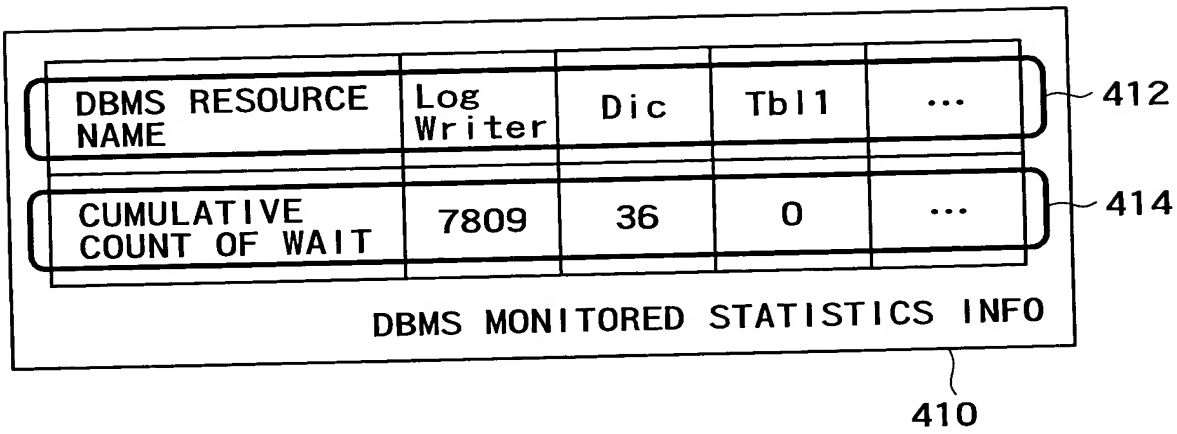

DBMS RESOURCE NAME
Log Writer
Dic
Tbl1
...
412
CUMULATIVE COUNT OF WAIT
7809
36
0
...
414
DBMS MONITORED STATISTICS INFO
410

FIG.25

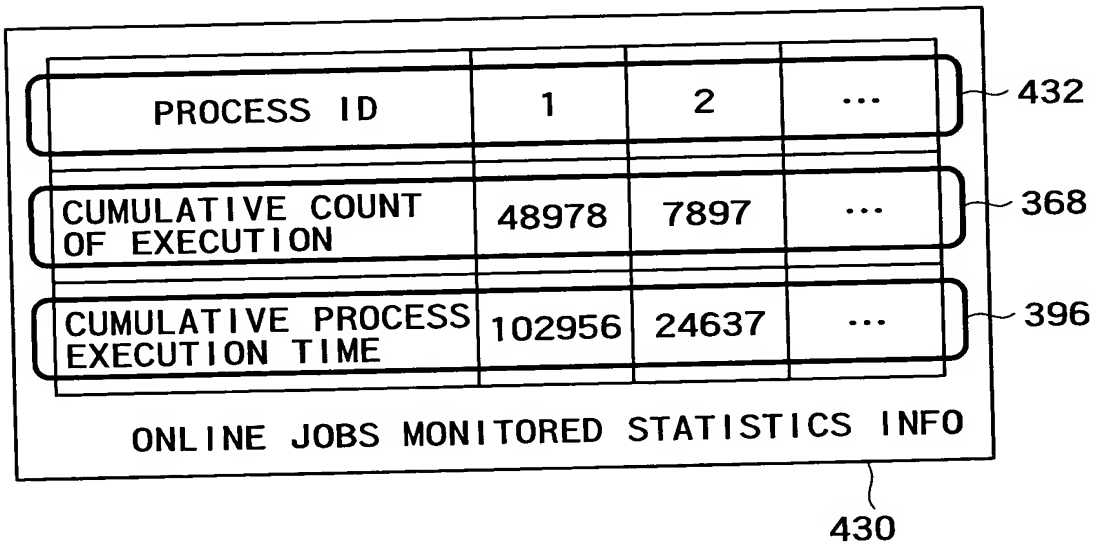

PROCESS ID
1
2
...
432
CUMULATIVE COUNT OF EXECUTION
48978
7897
...
368
CUMULATIVE PROCESS EXECUTION TIME
102956
24637
...
396
ONLINE JOBS MONITORED STATISTICS INFO
430

FIG.26

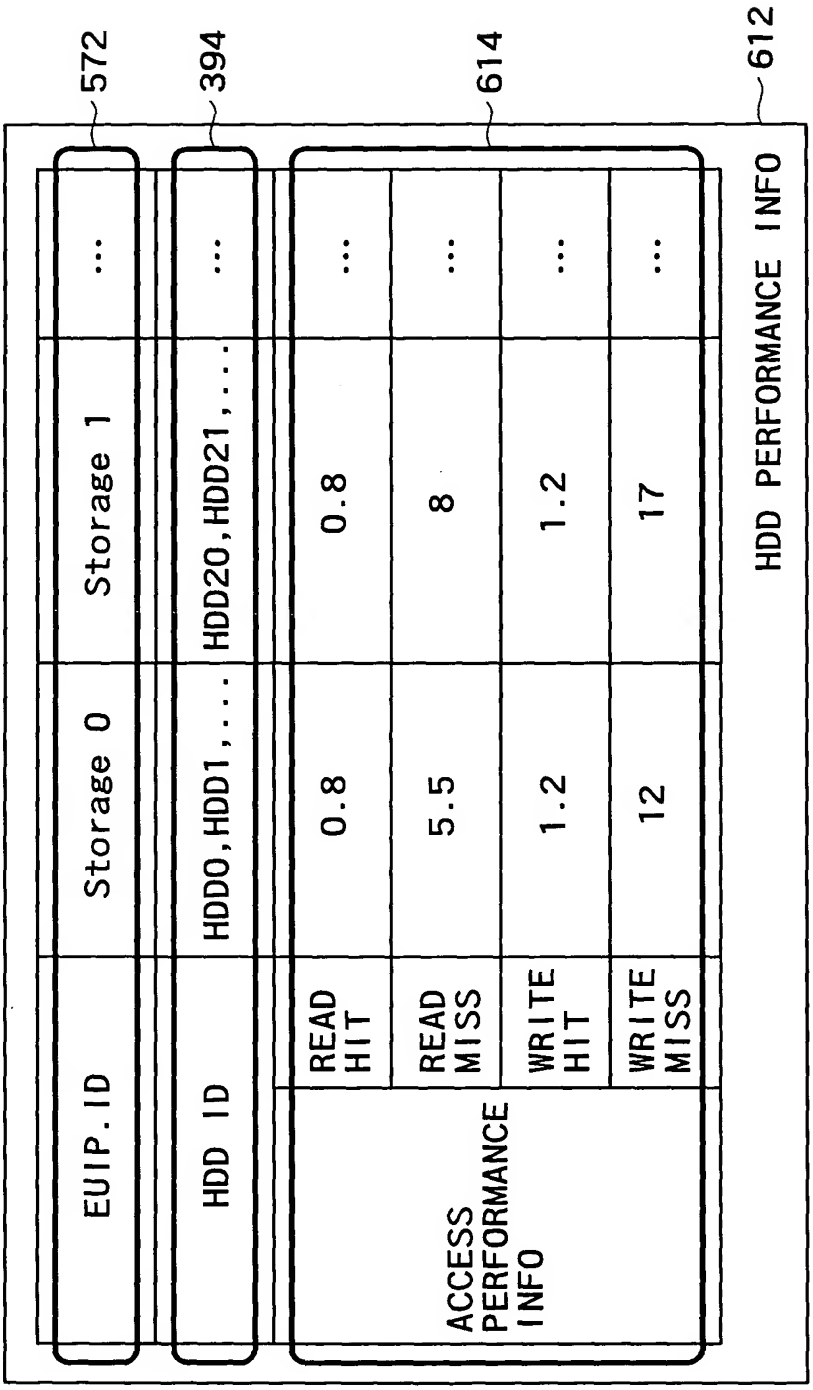

572
394
614
612
EUIP. ID
Storage 0
Storage 1
...
HDD ID
HDD0, HDD1, ...
HDD20, HDD21, ...
...
ACCESS PERFORMANCE INFO
READ HIT
0.8
0.8
...
READ MISS
5.5
8
...
WRITE HIT
1.2
1.2
...
WRITE MISS
12
17
...
HDD PERFORMANCE INFO

FIG.27

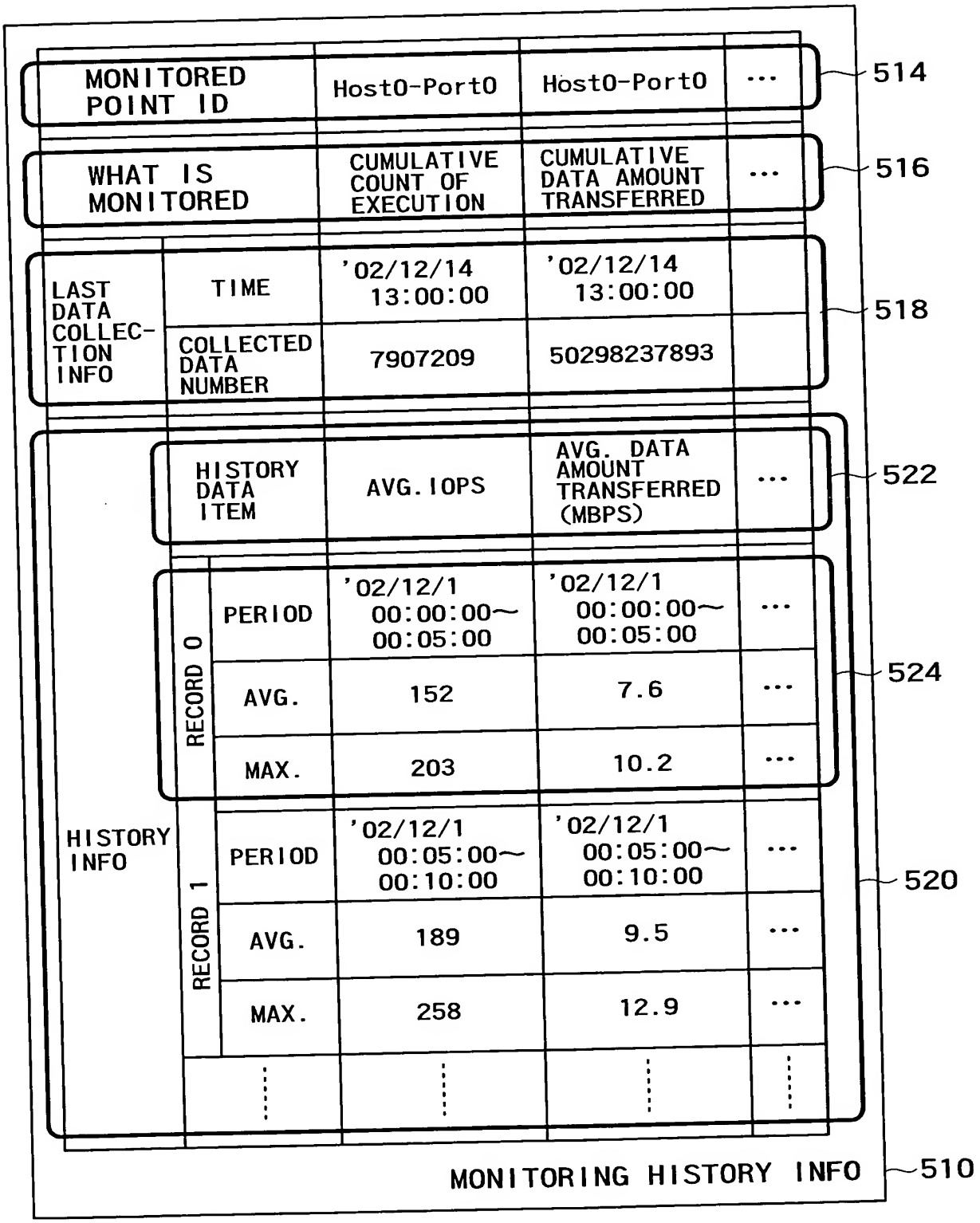

MONITORED POINT ID
Host0-Port0
Host0-Port0
...
514
WHAT IS MONITORED
CUMULATIVE COUNT OF EXECUTION
CUMULATIVE DATA AMOUNT TRANSFERRED
...
516
LAST DATA COLLEC-TION INFO
TIME
'02/12/14 13:00:00
'02/12/14 13:00:00
COLLECTED DATA NUMBER
7907209
50298237893
518
HISTORY INFO
HISTORY DATA ITEM
AVG. IOPS
AVG. DATA AMOUNT TRANSFERRED (MBPS)
...
522
RECORD 0
PERIOD
'02/12/1 00:00:00~ 00:05:00
'02/12/1 00:00:00~ 00:05:00
...
AVG.
152
7.6
...
MAX.
203
10.2
...
524
RECORD 1
PERIOD
'02/12/1 00:05:00~ 00:10:00
'02/12/1 00:05:00~ 00:10:00
...
AVG.
189
9.5
...
MAX.
258
12.9
...
520
MONITORING HISTORY INFO
510

FIG.28

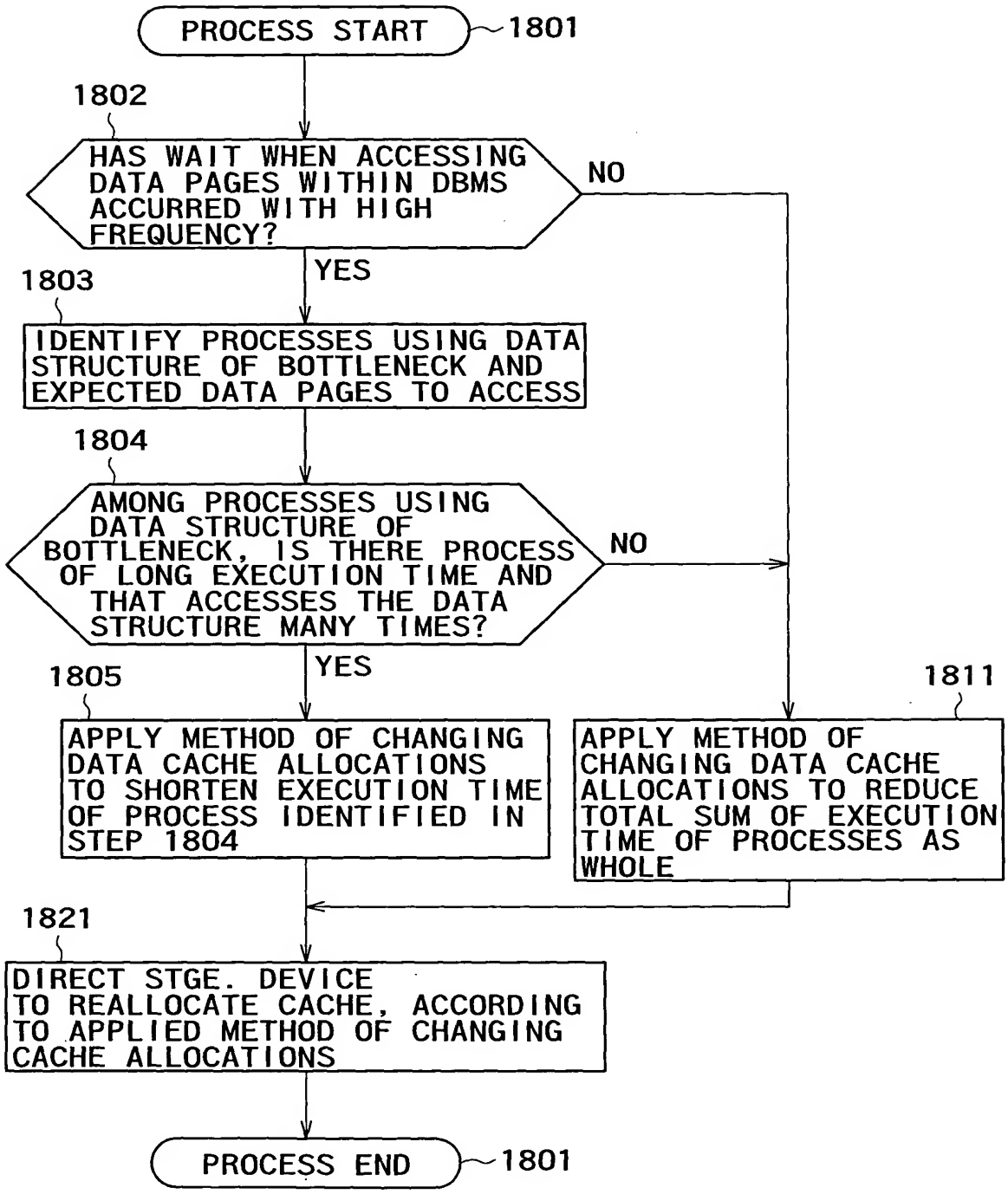
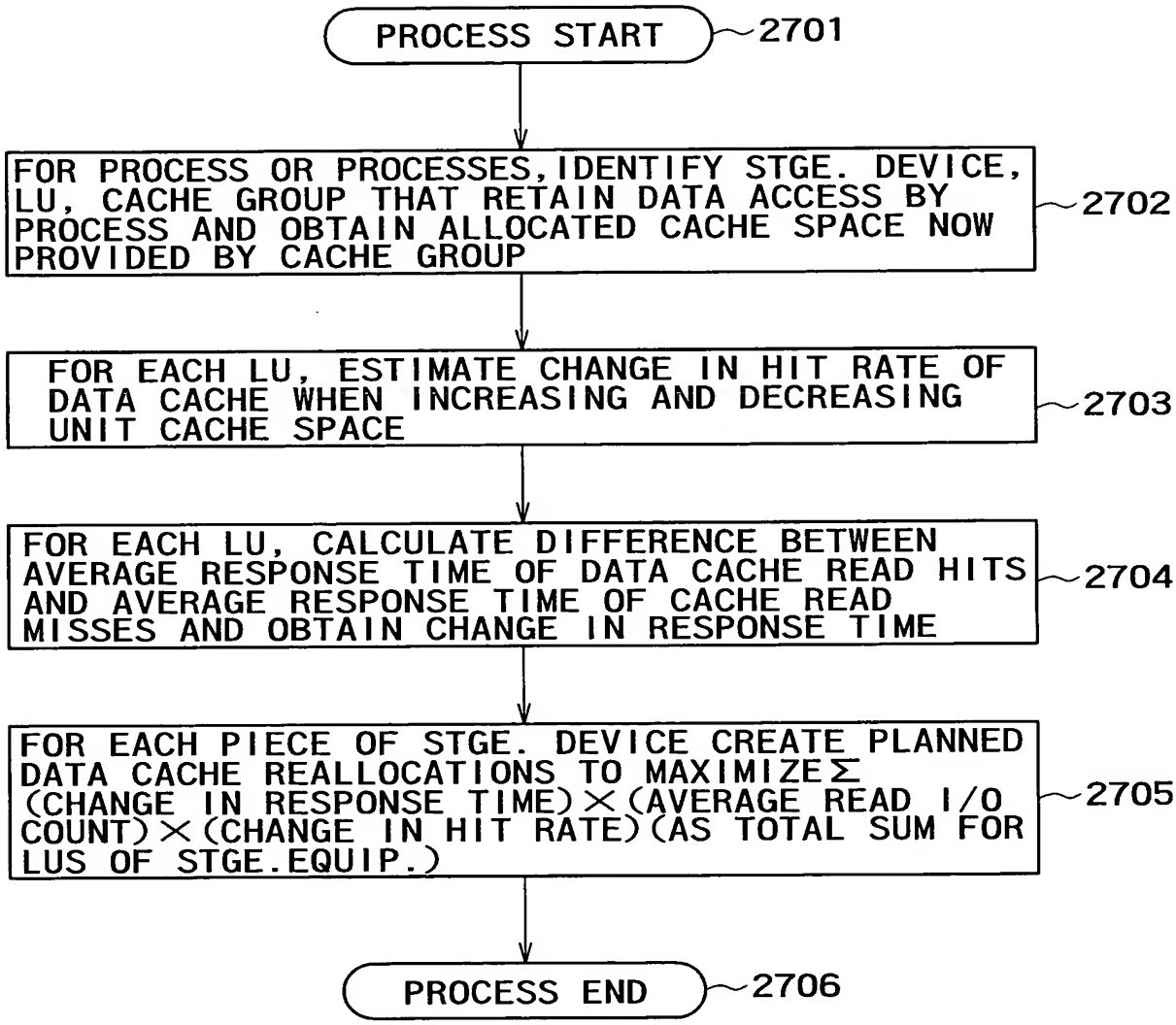

PROCESS START
1801
1802
HAS WAIT WHEN ACCESSING DATA PAGES WITHIN DBMS ACCURRED WITH HIGH FREQUENCY?
NO
YES
1803
IDENTIFY PROCESSES USING DATA STRUCTURE OF BOTTLENECK AND EXPECTED DATA PAGES TO ACCESS
1804
AMONG PROCESSES USING DATA STRUCTURE OF BOTTLENECK, IS THERE PROCESS OF LONG EXECUTION TIME AND THAT ACCESSES THE DATA STRUCTURE MANY TIMES?
NO
YES
1805
APPLY METHOD OF CHANGING DATA CACHE ALLOCATIONS TO SHORTEN EXECUTION TIME OF PROCESS IDENTIFIED IN STEP 1804
1811
APPLY METHOD OF CHANGING DATA CACHE ALLOCATIONS TO REDUCE TOTAL SUM OF EXECUTION TIME OF PROCESSES AS WHOLE
1821
DIRECT STGE. DEVICE TO REALLOCATE CACHE, ACCORDING TO APPLIED METHOD OF CHANGING CACHE ALLOCATIONS
PROCESS END
1801

FIG.29


PROCESS START
2701
FOR PROCESS OR PROCESSES, IDENTIFY STGE. DEVICE, LU, CACHE GROUP THAT RETAIN DATA ACCESS BY PROCESS AND OBTAIN ALLOCATED CACHE SPACE NOW PROVIDED BY CACHE GROUP
2702
FOR EACH LU, ESTIMATE CHANGE IN HIT RATE OF DATA CACHE WHEN INCREASING AND DECREASING UNIT CACHE SPACE
2703
FOR EACH LU, CALCULATE DIFFERENCE BETWEEN AVERAGE RESPONSE TIME OF DATA CACHE READ HITS AND AVERAGE RESPONSE TIME OF CACHE READ MISSES AND OBTAIN CHANGE IN RESPONSE TIME
2704
FOR EACH PIECE OF STGE. DEVICE CREATE PLANNED DATA CACHE REALLOCATIONS TO MAXIMIZE Σ (CHANGE IN RESPONSE TIME) × (AVERAGE READ I/O COUNT) × (CHANGE IN HIT RATE) (AS TOTAL SUM FOR LUS OF STGE.EQUIP.)
2705
PROCESS END
2706